THE INFLUENCE OF PHYSICAL ACTIVITY BEHAVIOUR ON THE RELATIONSHIP BETWEEN MOTOR PROFICIENCY AND BODY COMPOSITION IN CHILDREN

Data from the Physical Health Activity Study Project

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Submitted in partial fulfillment
of the requirements for the degree
Master of Science in Applied Health Sciences
Health Science

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ACKNOWLEDGEMENTS

I wish to express sincere appreciation to the Department of Applied Health Sciences for their assistance and extended support. I would especially like to acknowledge Dr. John Hay for his continued patience, expertise in the field of motor proficiency, and for providing extensive resources and guidance. A special thanks as well to Dr. Jian Liu for his helpful advice and in-depth statistical knowledge and Dr. Brent Faught for his insightful suggestions and opinions. I would also like to genuinely thank Darren for his valued advice, support and statistical assistance. This thesis would have never been completed without the devotion and encouragement of my friends and family. Their support and love has motivated me to achieve my goals and for that I thank them.

Jennifer MacInnis

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THE INFLUENCE OF PHYSICAL ACTIVITY BEHAVIOUR ON THE RELATIONSHIP BETWEEN MOTOR PROFICIENCY AND BODY COMPOSITION IN CHILDREN

ABSTRACT

There is an emerging awareness that children with poor motor abilities are at particular risk for overweight. This cross-sectional study examined the influence of physical activity behaviour on the relationship between motor proficiency and body composition.

Participants were1287 (646 males, 641 females) Grade 6 students in the Physical Health Activity Study project. Height, weight, waist girth, and motor proficiency (Bruininks-Oseretsky Test of Motor Performance BOTMP-SF) were assessed. Physical activity behaviours were also evaluated with a multifaceted approach and reported for school-based, non-school based physical activity, free-time play, and sedentary activities (Participation Questionnaire), and leisure time exercise (Godin-Shephard Leisure Time Exercise Questionnaire GS). Overweight was defined by BMI scores: boys $\geq$20.6-21.2 and <25.1-26.0; girls: $\geq$ 20.7-21.7and <25.4-26.7 and obesity was defined as: boys: $\geq$ 25.1-26.0; girls: $\geq$25.4-26.7. Children were classified as case group (CG, $\leq$ 10% on BOTMP-SF), borderline case group (BC, >10% to $\leq$ 20% on BOTMP-SF) or non-case group.

Analyses of variance (ANOVAs) uncovered a significant difference in overweight and obesity between the case group and non-case group. Normal-weight children reported higher participation in organized school-sports (intra-mural and inter-school teams). The CG reported significantly lower participation in school sports teams and lower GS results, with a trend towards lower participation in all active pursuits. They also reported a significantly higher duration of television watching and book reading. There

were no significant differences between motor proficiency groups by gender, age, non-school sports, or free-time activity. Multivariate ordinal logistic regression analysis showed that the case group was 10.9 times more likely to be overweight/obese than their peers. No single aspect of physical activity was able to explain the difference in odds ratios for the motor proficiency groups. However, for the entire cohort, children who participated in more organized school sports were less likely to be overweight/obese.

These findings confirm that children with low motor proficiency are at significant risk of developing overweight. It is evident that these children have generally attenuated activity levels and heightened levels of sedentary pursuits. School-based activities appear particularly limited, and are the one area where children have near autonomy in their decision to pursue active opportunities. The promotion of school-based programs, specifically intramural sports may be an important aspect in increasing children's overall activity levels. It is also essential to consider the needs of those children with low motor proficiency when designing activity promotion programs. Future research should further explore motor proficiency and overweight/obesity.

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Chapter I: Introduction

This chapter will provide an overview for the need to investigate factors related to obesity, and specially focus on physical activity behaviours. It will also present a rationale for studying chronic childhood disorders such a low motor proficiency.

1.1 Childhood Obesity

Childhood obesity is a cause for great concern. The prevalence of overweight and obesity in children continues to rise, and a staggering 20% of Canadian children are considered to be obese (Tremblay, Katzmarzyk & Willms, 2002). This trend is worrisome due to the many adverse health consequences associated with this condition.

The short-term consequences of obesity include; adverse effects on blood lipids, blood pressure, growth, and glucose metabolism (Gidding, Bao, Srinivasan & Berenson, 1995). Many chronic diseases such as coronary heart disease, type 2 diabetes, hypertension, respiratory disease, stroke, gallbladder disease, and certain forms of cancer are also linked to obesity (Whitaker, Wright, Pepe, Seidel & Dietz, 1997). It is important that the causes\effects of obesity in childhood are investigated in order to develop successful interventions and programs to conquer this problem.

Recognizing the factors that are associated with obesity will make it clear where to intervene and how to design effective programs. Although the health effects of obesity are well understood, the cause is still debatable. Childhood obesity primarily results from a positive energy balance, but the factors that lead to this are not well understood (Katzmarzyk, 2002). The increase in youth obesity could be explained by any number of factors that influence energy intake or expenditure (Janssen, Katzmarzyk, Boyce, King & Pickett, 2003).

Numerous risk factors for overweight have been recognized, including genetic and familial predisposition, psychosocial factors, physical, lifestyle and environment early in life (Strauss, & Knight, 1999). Furthermore, current studies have argued that geographical and socioeconomic gradients are risk factors for overweight and obesity in childhood (Veugelers, & Fitzgerald, 2005). However, it is unclear if these factors act independently in the trajectory of weight gain, or if they are linked to inactivity.

Recent evidence supports low energy expenditure as a result of reduced participation in physical activity and more time spent in sedentary behaviors, as a major contributor to obesity (Bouchard, 2000). Therefore, it is necessary to recognize the factors related to physical activity in childhood for effective prevention of inactivity and overweight across the lifespan (Koezuka, Koo, Allison, Adlaf, Dwyer, Faulkner & Goodman, 2006).

1.2 Motor Proficiency

Currently, there are few effective treatments to decrease weight and maintain the loss among overweight individuals (Berkey et al., 2000). Understanding the origin of hypoactivity is a crucial step in ensuring the success of activity promotion programs. According to Hay et al. (2003), until recently, motor proficiency has been neglected when barriers to activity are regarded. An understanding of the habitual physical activity levels of children and particularly those with chronic movement disorders is vital for both treatment and monitoring (Hay & Cairney, 2006).

Most recently it has been suggested that motor proficiency affects physical activity and physical fitness levels (Cairney, Hay, Faught, Mandigo & Flouris, 2005). It has also been hypothesized that motor incompetence leads to a decrease in participation

of organized and free-play activities (Cairney et al., 2005).

On the far end of the spectrum of motor proficiency is Developmental Coordination Disorder (DCD). The Diagnostic and Statistical Manual (1994) first defined DCD as: "1) a marked impairment in the development of motor cordination; 2) the impairment interferes with academic achievement or activities of daily living; and 3) the coordination difficulties are not owing to a general medical condition or Pervasive Developmental Disorder." These children demonstrate very low levels of motor proficiency in the absence of any known neuromuscular disorder (American Psychiatric Association, 1994). DCD is a disorder characterized by poor coordination and clumsiness, and is diagnosed when children do not develop normal motor coordination (coordination of movements involving the voluntary muscles) (American Psychiatric Association, 1994).

The prevalence of DCD in North American school-aged children is predicted to be 5-10%, which ranks it among one of the most prevalent childhood disorders (Cairney, Hay, Faught, Flouris & Klentrou, 2007). Regrettably, the problem of decreased motor proficiency is unrecognized and under diagnosed.

Children with low motor proficiency are also more likely to be obese (Cairney et al., 2005). Research has demonstrated that there is a link between motor proficiency and body composition, and it is assumed that lower levels of physical activity in children mediate this (Cairney et al. 2005). However, it is unclear how physical activity behaviours influence this relationship and there is lack of data available that explores various physical activity behaviours in depth.

1.3 Physical Activity

It is essential to understand the role that physical activity plays in the course of weight gain. In particular, there is a need to recognize how physical activity levels in children with poor motor proficiency are affected, and if this influences body composition. This absence of data is problematic, as without an understanding of these associations, these individuals remain subject to the many challenges typically faced by obese children and those who have poor motor proficiency.

There are also few studies that examine the relationships between the various components of physical activity (PA) such as free-time activity, organized sports (school-based and non-school based) and sedentary behaviours. This is necessary due to the intricacy of these behaviours. The majority of published studies have concentrated on physical activity levels by primarily focusing frequency, and this does not address the complexity of this topic (Salbe et al., 2002). It is necessary to explore different physical activity behaviours in depth. This insight will allow a better understanding of how physical activity is associated with body composition, and may be a valuable tool in targeting primary prevention. Knowledge in this area may also be useful in the future when intervening with a particular child.

1.4 Objective

This thesis will examine the influence of physical activity behaviours (free-time activity, school based and non-school based activities and sedentary behaviour (television, reading books, and inactive choices)) on the relationship between motor proficiency and body composition in children (Figure 1).

Chapter II: Review of Literature

2.1 Introduction

This review of literature will thoroughly investigate research involving motor proficiency, physical activity and obesity. The chapter will conclude with an explanation on how this thesis will positively contribute to the research already available in this area, and how studying the relationships between motor proficiency, physical activity behaviours, and body composition in childhood is necessary.

There is a substantial body of research that supports the strong influence of certain factors in the development of obesity. Several risk factors for overweight have also been recognized, including genetic and familial predisposition, socioeconomic factors, and environment early in life (Strauss, & Knight, 1999). However, it is unclear if these factors act independently in the trajectory of weight gain or if they are linked to inactivity and indirectly play a role in weight gain.

2.2 Classification of Overweight/Obesity

In order to study childhood overweight and obesity, the first step is to accurately define it and to consider techniques available to classify this condition. Obesity is commonly defined as a condition of extreme body fat and is associated with a large number of debilitating and left-threatening disorders (Katzmarzyk, 2002). This state is due to persistent energy imbalance where for whatever reason intake surpasses expenditure (Katzmarzyk, 2002). Simply defining obesity and overweight among children can be difficult and the majority of definitions are based on weight for height or weight for age. Obesity is expressed in terms of body fat content, however in clinical

practice and epidemiology, it is very difficult to measure body fat content (Reilly, 2006). Since it is seldom that actual body fat content is measured accurately and precisely, alternative definitions are required. According to Reilly (2006), past research supports the inadequacy of subjective assessment and the objective approach of body mass index (BMI: weight in kg divided by height in m^2) is the best existing option. BMI does not measure body fat directly, but studies have revealed that BMI correlates to direct body fat measures, such as dual energy x-ray absorptiometry (DXA) ($r = 0.80–0.90$) and underwater weighing (Mei, Pietrobelli, Goulding, Goran & Dietz, 2002). BMI measures also correlate well with health measures, including blood pressure, adverse lipoprotein profiles, atherosclerotic lesions, serum insulin levels, and diabetes mellitus in adolescent samples (Dietz & Robinson, 1998). Body mass index is an alternative for the direct measure of body fat and is an inexpensive, quick and easy method for screening for weight categories that may be at risk for overweight or obesity (Mei et al., 2002). Due to the ease of assessment of the BMI, it has been recommended as the measure of choice for epidemiologic research (Dietz & Robinson, 1998). After an individual's BMI is established, the value can be plotted on the Centers for Disease Control and Prevention (CDC) BMI-for age growth charts (for boys or girls) to determine the percentile ranking (Figure 2 & Figure 3) (Cole, Bellizzi, Flegal & Dietz, 2000). Growth charts are based on percentiles and they are the most commonly used clinical indicator to assess size and growth patterns of individual children. They rank the position of an individual with reference to the rest of the population and the weight status categories used with children and teens are illustrated in Table 1 (underweight, healthy weight, at risk of overweight, and overweight) (Division of Nutrition and Physical Activity, National Center for

Chronic Disease Prevention and Health Promotion, 2006). A percentile range of 85th to less than the 95th percentile is considered at risk for overweight and a BMI value that is equal to or greater than the 95th percentile is deemed overweight. Based on evidence in the UK, it has been proposed that overweight and obesity should be defined as BMI >85th and >95th percentiles in epidemiology and research (Reilly, 2006). Children and adolescents with a high BMI percentile are likely to be extremely fat and therefore this definition has a high diagnostic specificity (low false positive rate) (Reilly, 2006).

The World Health Organization (WHO) (1998) has also published international standards for classifying overweight and obesity in adults. This classification is based on an individual's BMI value and this falls within the category of normal or overweight: pre-obese, or obesity class 1, 2, or 3 (Table 2). However, when focusing on childhood overweight and obesity, more specific definitions are required because they cannot be categorized using the adult system. Cole, Bellizzi, Flegal, & Dietz (2006) modified the accepted cut-off values for adults and developed standard age and sex-specific BMI cut-off points for child overweight and obesity (Table 3). For example, an 11 year-old is defined as overweight with a BMI of 20.6 or more for boys and 20.7 for girls, with obesity defined as a BMI of 25.1 or more for boys and 25.4 or greater for girls.

The obvious downside of using BMI as the sole criteria for defining overweight and obesity is that these evaluations ignore the contribution of fat mass to lean mass ratio. In children and in adults, centralized or upper body fat is associated with an elevated risk for metabolic complications (McCarthy, Ellis & Cole, 2003). Measurements of tricep skin folds in addition to the use of BMI may narrow this problem. However, this method requires a skilled technician to operate calipers. Measurements of waist circumference

are also highly sensitive and specific for abdominal body fat in children and may be helpful for identifying overweight and obesity (McCarthy et al., 2003). It has been suggested that focusing solely on BMI measurements to determine overweight and obesity in children may underestimate the scale of this problem. McCarthy et al., (2003) have shown that in England, secular trends in fat distribution (shown by changes in waist circumference) have been even more prominent than secular trends in BMI, demonstrating a more intra-abdominal or central fat distribution pattern in modern children. This evidence also suggests that that the negative consequences associated with childhood overweight and obesity may have been underestimated due to the exclusive use of BMI. It has also been noted that the use of BMI to define obesity in adults has the disadvantage of under-diagnosing obesity in non-white populations (Deurenberg, Yap & Van Staveren, 1998).

Therefore, it can be assumed that the best definition of childhood overweight and obesity would include BMI and body circumference measures. Nevertheless, measurements of waist-hip ratios, which reveal morbidity risk in adults, are commonly agreed upon as having uncertain implications in children (Power, Lake & Cole, 1997). Even if measurements of body circumference did measure adiposity, the relationship between visceral fat and morbidity has yet to be clarified. Finally, according to Power et al. (1997) the association between body fat distribution and childhood morbidity is unclear. For that reason, BMI is generally considered to be the best single determinant to define obesity in children from 2-20 years of age (Cole et al., 2000).

2.3 Risk Factors for Obesity

In the most straightforward explanation, it is generally believed that a chronic positive energy balance results in obesity (Reilly, 2006). The size of this energy disparity may be quite small at any given point, but when prolonged, the additive effect results in obesity. Currently, it is accepted that identifying an energy imbalance as a cause of obesity may have limitations (Wells, 1998). Although childhood obesity is primarily a result of an energy imbalance, the etiology is multifactorial. Since it involves social, cultural, environmental, and genetic components, these factors should all be investigated (Ekelund, Sardinha, Anderssen, Harro, Franks, Brage, Cooper, Andersen, Riddoch, & Froberg, 2004). It has been suggested by Wells (1998) that the various risk factors for overweight and obesity may be more easily measurable than total energy expenditure and more valuable. This is due to the fact that they represent behavioural targets for preventative interventions in the future.

There are a wide-range of risk factors that have been associated with overweight and obesity. It is commonly believed that genetic factors support the energy imbalance that leads to obesity (Krebs & Jacobson, 2003). According to Gidding, Rudolph, Daniels, Rosenbaum, Van Horn & Marx (1996) in twin studies it has been demonstrated that the heritability of body fatness and body fat distribution has been estimated to be 65% to 75%. Persistence of childhood obesity into adulthood is more probable when children had at least one obese parent, where obesity is more of an obvious outcome at older ages (Whitaker et al., 1997). Although genetics may raise an individual's risk of obesity, their interaction with environmental influences, including health-related behaviours and lifestyle is what ultimately predicts the risk of obesity (Whitaker et al., 1997).

It has been suggested that the increase in the prevalence of body fat is likely a result of environmental changes, such as an increase of portion sizes of high-energy foods and reduced physical activity levels (Hill & Peters, 1997). In the past century, research has suggested that food intake; particularly high-fat food has increased, although this data is conflicting (Salbe et al., 2002). Other environmental factors associated with childhood obesity may involve socioeconomic status (SES). According to Burke et al. (2004) a lower BMI in six and eight year olds was related to a higher family income with tertiary education in mothers, consistent with the inverse association displayed between SES and BMI in children older than six years old. These results suggest that both maternal deprivation and other early social influences such as parental occupation and education are closely related to the development of obesity in childhood (Stamatakis, Primatesta, Chinn, Rona, & Falascheti, 2005).

The pandemic of pediatric obesity cannot be clarified by genetic or environmental factors alone. Commonly, obesity aggregates in families and high birth weight, gestational diabetes, and obesity in family members all are risk factors. Obesity can also be recognized through an interaction of more than 250 different genes, but the obesity phenotype comes from gene-environment interactions (Snyder, Walts, Perusse, Chagnon, Weisnagel, & Rankinen, 2003). Other issues that have been suggested to play a role in the development of this condition are hormonal or glandular problems, breast-feeding, placental weight, first-born status, maternal pregnancy weight gain, parental smoking, sexual maturation, presence of father in the household, or the number of adults in the household, dieting, binge eating and depression (Stice, Presenall, & Shaw, 2005; Reilley et al., 2005; Kanbur, Derman & Kink, 2002).

These factors may all be connected to the development of obesity. However, these relations have not yet been consistently observed, and it is unclear which of these have factors are directly related to overweight status. Also, these factors are not directly influenced by motor proficiency and beyond the scope of this investigation. Generally, physical activity is believed to have the strongest association in the trajectory of weight gain. Not only is it directly related to the development of obesity, it also indirectly affects the many variables previously mentioned. Therefore, this study will focus on factors that are directly associated with physical activity and influenced by motor proficiency.

2.4 Effects of Motor Proficiency

Physical activity and physical fitness levels are affected in children with low motor proficiency. It has been determined that this condition leads to a decrease in participation of organized and free-play activities (Cairney, Hay, Faught, Mandigo & Flouris, 2005). On the far end of motor competence is developmental coordination disorder (DCD). DCD is a childhood disorder characterized by poor coordination and clumsiness, and is diagnosed when children do not develop normal motor coordination (coordination of movements involving the voluntary muscles) (American Psychiatric Association, 1994). Children with DCD usually have difficulty performing tasks that require both large and small muscles. They also demonstrate very low levels of motor proficiency in absence of any known neuromuscular disorder (Cairney et al., 2007). Individuals who have this condition have often developed normally in all other ways (American Psychiatric Association, 1994). However, this condition tends to lead to social or academic problems for children. Due to underdeveloped coordination, a child

with poor motor competence may choose not to participate in activities on the playground (Cairney et al., 2005).

Currently, there is no gold standard to diagnose DCD, and a lack of effective screening devices for early detection (Hay et al., 2003). Motor proficiency is typically diagnosed with motor competence tests such as the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), or the Movement Assessment Battery for children (M-ABC). In North America, motor proficiency is typically evaluated in large population studies using the short form Bruininks-Oseretsky Test of Motor Proficiency (BOTMP-SF), which has been validated (Briuninks, 1978). This assessment observes many aspects of motor proficiency such as static and dynamic balance, bilateral coordination and reaction time (Cairney et al., 2005). There are, however, limitations to the methods used to test for motor proficiency. They tend to be expensive and time consuming, and trained personnel are required. Also, only one child can be screened at a time (Hay et al., 2003).

Children who lack sufficient motor competence skills are less likely to be physically active, compared to children without this circumstance (Cairney et al., 2006). This deficit is most likely caused by a lack of confidence in the child's physical abilities. Hay (1992) concluded that a child with DCD has a lower sense of self-efficacy toward physical activity, and this may be due to exclusion from activities from a child's peers. These children may shy from taking part in PA because they may not perceive themselves to be sufficiently adequate to satisfy the minimum performance requirement. A predilection for sedentary activities and an avoidance of structured PA opportunities is most likely a way to deal with the possible outcome of failure and humiliation they may face (Cairney, Hay, Faught, Wade, Corna & Flouris, 2005). Girls have also been found to

report lower generalized self-efficacy toward physical activity when compared to boys (Hay, 1992). An individual's generalized self-efficacy towards physical activity is characteristically determined using the Children's Self-Perception of Adequacy in and Predilection for Physical Activity (CSAPPA) scale (Hay, 1992).

Children with low motor proficiency are unlikely to outgrow their condition and they are at increased risk for behavioural and emotional problems as they age (Cantell, Smyth & Ahonen, 2003). In order to determine group stability, the ideal method is to measure performance of children for a specific task and repeat this evaluation some time later. If group stability is present, the same individuals maintain their relative position in the group over time, and a high correlation coefficient between the initial measurements and results of the second measurement will be evident (Corbin, 1982). Correlations between test measurements for group stability at three to four year intervals are around 0.70. A study by Rarick & Smoll (1967), which was considered the longest test of generalization, established correlations of group stability around 0.50 and 0.80 for girls aged seven to eighteen. They also reported similar findings for boys aged eight to eighteen with values of 0.60 and 0.56 (Rarick & Smoll, 1967).

The stability of low motor proficiency measurements in children is worrisome, especially because low motor competence is linked with low levels of physical activity. As a consequence of the motor impairment observed in DCD, these children tend to avoid physical activity (Cairney et al., 2007). Therefore, it is expected that these children would have a greater likelihood of poor cardiorespiratory fitness. A study by Cairney et al. (2007) supported this view and determined that children with motor coordination problems reported lower cardiorespiratory fitness than healthy children. They found that

the participants with DCD scored at or below the 20th percentile in peak VO_2. The presence of lower cardiorespiratory fitness levels in children with DCD should be of great concern because it suggests a tendency for these children to develop poor cardiovascular health as they age (Cairney et al., 2007).

In addition to low physical activity levels, children with motor incompetence are more likely to be obese (Cairney et al., 2005). It has been established that there is a connection between physical inactivity and motor ability. Unfortunately there is limited information available on detailed physical activity behaviours and how they relate to motor proficiency and body composition, and this warrants further exploration.

2.5 Physical Activity

The amount of time children spend on sedentary activities has been linked to overweight and obesity, mainly because it is related to energy expenditure. Unfortunately, there is a disagreement on the best measurement of physical activity. This makes it complicated to support the idea that sedentary behaviour and the occurrence of obesity have amplified simultaneously (Ekelund et al., 2004). It is also more difficult to assess physical activity levels and patterns in children compared to adults (Ekelund et al., 2004).

Measuring the subcomponents of physical activity in epidemiologic studies is complicated because of the complex and underlying nature of the exposure (Wareham & Rennie, 1998). The majority of studies that assess physical activity levels use physical activity questionnaires. These surveys often assess the average hours per week during the past year in which the child typically participates in recreational activities and sports. (Kriska, Knowler & LaPorte, 1990). It also considers the energy expenditure greater than

what is normally required for activities such as daily bathing, grooming and food consumption (Kriska, Knowler & LaPorte, 1990). Additional questions also account for the number of hours that children engage in activities that require little energy expenditure such as sleeping, television viewing, and playing video or computer games, and this provides knowledge on physical activity behaviours (Kriska et al., 1990).

A five-year longitudinal study conducted by Salbe et al. (2002) assessed physical activity levels in 138 five-year old Pima Indian children using activity questionnaires. It confirmed that low rates of energy expenditure in early childhood do not predict the development of obesity years later. However, the outcome did indicate that differential changes in physical activity occur in children who are at risk of becoming obese. Obesity at baseline was associated with decreased participation in sports and increased television watching (Salbe et al., 2002). Also, failure to enhance activity levels in response to gaining weight may encourage obesity in preadolescence (Salbe et al., 2002). Still, a major limitation was that they had a small sample size, and a lack of power for their study.

The studies that assess the link between physical activity and obesity using self-report methods make it difficult to distinguish causal relationships. Additionally, these methods lack validity in young children, and have the potential for recall bias. Therefore, it has been suggested that this technique should not be used in children under the age of 10 (Tarasuk, & Beaton, 1991).

However, self-report data may still be useful in providing a crude estimate of the amount of time exhausted during various types of physical activity. An alternative method for measuring physical activity is the use of motion sensors or accelerometers.

These methods provide thorough data on the duration and intensity of physical activity on a minute-by-minute basis (Sawaya, Tucker & Tsay, 1996). Accerlerometry measurements also have high validity when compared with self-report data. They also provide information on the total amount of PA and its subcomponents, and are practicable for use in large-scale studies (Salbe et al., 2002). However, according to Ekelund et al. (2004) there are limitations with accelerometers. They may not accurately reflect energy expenditure connected with upper body movement, walking uphill, stairclimbing, and bicycling and aquatic activities. Also, the cutoffs employed to define intensity are subjective (Ekelund et al., 2004). Another limitation is that accelerometers do not allow the study of the various types of physical activity.

Results of an epidemiologic study of 7216 children ages 7 to 11 years supported a link between physical inactivity and obesity in Canadian children (Tremblay & Willms, 2003). It was suggested that television viewing plays a large part in this pandemic. One limitation to this study however was for a select group of participants BMI was derived from parental reports. Another prospective study consisting of 700 children aged 10 to 15 years followed for four years illustrated that children watching television more than five hours per day were five times as likely to be overweight compared to those watching less than two hours a day (Gortmaker, Must, Sobol, Peterson, Colditz & Dietz, 1990). According to Robinson (1999) who conducted a randomized controlled trial, reducing the amount of television school-aged children watched results in a lower BMI, compared to the control group. This was observed without specifically promoting more active behaviour. Although this study had significant findings, it was noted that only two elementary schools were tested, and the possibility of the results due to differences in

groups could not be ruled out. It is however apparent that there are now increased chances for children to be sedentary in their leisure time through greater access to television, computer, and video games (Salmon, Ball, Crawford, Booth, Telford, Hume, Jolley & Worsley, 2005).

It has been demonstrated that physical activity and physical inactivity play an important role in body composition in childhood, and both aspects should be explored in more depth. An understanding of the full extent of physical inactivity by studying physical activity behaviours is required to ensure the success of future activity promotion interventions. In order to fully grasp the root causes of hypoactivity, it is necessary to also research chronic conditions that are linked with low activity levels, such as poor motor proficiency.

Chapter III: Methodology

3.1 Participant Recruitment and Sample Selection:

This cross-sectional study will make use of the Physical Health Activity Study Team (PHAST) data obtained at various points over the last three years (Appendix A). The majority of the data will be drawn from Year 3 (2006), Wave 2 of the PHAST study, with the exception of the movement skills appraisals and the parental questionnaire. Information was obtained from 2260 (1125 males, 1135 females) District School Board of Niagara (DSBN) boys and girls in grade 6, aged 11-12 y. involved in Wave 2, Year 3 of the PHAST study. Participants included children from 75 of the 92 DSBN public schools across the Niagara Region. However, individuals with missing PHAST ID's, motor proficiency data and/or body composition measurements were excluded from the study. Therefore, a total of 1287 (646 males, 641 females) individuals were included in the final sample (Table 4).

Subjects undertook fitness and body composition appraisals, and completed two questionnaires at school about physical activity and leisure time activities (Participation Questionnaire (Appendix B), and Godin-Shephard Leisure Time Questionnaire (Appendix C)). Movement skill appraisals (Bruininks-Oseretsky Test of Motor Proficiency (BOTMP-SF)) were conducted on 25 schools randomly selected each year until all 75 schools had been tested (Appendix D). There were also 89 participants from 5 randomly selected schools that had motor proficiency assessments on two separate occasions 12-24 months apart. All parents gave informed written consent for their children to participate and also completed a parental questionnaire (Appendix E). The Research Ethics Board of Brock University and the District School Board of Niagara

both approved the protocols for this study.

3.2 Movement Skills Appraisals

The Bruininks-Oseretsky Test of Motor Proficiency-Short Form (BOTMP-SF) was used to evaluate children's motor ability (Bruininks, 1978). This measurement has been validated against the full-scale with inter-correlations between 0.90 and 0.91 for children between the ages of 8 to 14 (Briuninks, 1978). In North America, the Bruininks-Oseretsky test (BOTMP) is the most commonly used standardized test to diagnose DCD (Crawford, Wilson & Dewey, 2001). The short form version examines the full scope of motor proficiency, making use of selected items from the full scale. This assessment consists of 14 items taken from the 8 subtests that correlate highly with the subtest score and the total score. The 8 subtests assess gross motor development, including running speed and agility, balance, bilateral coordination, and strength; gross and fine motor development, including upper limb coordination; and fine motor development, including response speed, visual-motor control, and upper-limb speed and dexterity. The short form has been designed to use when a large number of participants are studied and provides an excellent assessment of general motor functioning, although it does not provide in-depth analysis of each aspect (Hay, Hawes & Faught, 2003). The BOTMP-SF was privately administered to each child in each school's gymnasium. A standard score (age-adjusted) below 38 or below the 10th percentile rank on this test is necessary for a diagnosis for low motor proficiency (probable DCD) (Cairney, Hay, Faught, Corna, & Flouris, 2006). This cut-off value has been used in past research to determine probable cases of DCD and it has been demonstrated that children diagnosed with motor proficiency are unlikely to outgrow their condition (Cairney et al., 2005). This cut-off also corresponds to

population-based estimates of the prevalence of this disorder (American Psychiatric Association, 1994). Subjects will be classified into tertiles based on their BOTM-SF percentiles and grouped as: 0% to ≤ 10% (case group), >10% to ≤ 20% (borderline case), or >20% to ≤ 100% (non-case). The case group will represent the individuals with the lowest motor proficiency levels, and these children will be classified as having DCD. The borderline case-group will characterize children as having lower motor proficiency levels compared to their peers, however their MP levels are not low enough to classify them as having DCD. The final non-case group will represent individuals that have normal motor performance.

3.3 Assessment of Physical Activity Behaviours

3.3.1 *Relative Frequency*

Physical activity (PA) was assessed by the participation questionnaires (PQ) that consisted of 63 questions, developed by Hay (1992). The PQ establishes a framework from which a useful measurement for determining physical activity can develop (Hay & Cairney, 2006). This survey evaluates participation levels in areas of seasonal recreational activities, free-time play, school sports; community sports clubs and teams, and sports and dance lessons, as well as sedentary activities. Multiple choice, Likert scale type, and free-response areas make-up this questionnaire. Participation in organized sports is from a one-year period, and free play activities are chosen from typical pastime choices. Subtotals for free-play, organized activities (sports teams and lessons) and inactive choices are provided. The scale is scored in "activity units" with each representing a physical activity choice, dance or sport lesson, or sport team. The PQ provides an estimation of a child's frequency and nature of PA, but does not address

overall intensity or duration. A high test-retest reliability of 0.81 has been previously demonstrated for the Participation Questionnaire among elementary school children (Hay, 1992). It also allows the definition of three items (behaviours): relative frequency (free-time activity), type of physical activity (organized vs. non-organized), and sedentary behaviours. For the relative frequency of PA, participants will have a final score, with 20 being the most active. Individuals will be further divided into "low" (0-5 active points), "low-moderate" (6-10), "moderate-high" (7-15) and "high" (16–20) categories, based on the number of active events they recorded in the free-time activities section.

3.3.2 *Inactivity Score*

Inactive choices will be another aspect of physical activity that can be measured from the free time activities section. This can be calculated by using the equation:

Inactive Choices = Highest Possible Free-Time Activity Score – Actual Reported Score.

This will yield a value for a child's inactive/sedentary choices during their free-time.

3.3.3 *Organized Sports*

The questionnaire included a section that allowed a focus on the type of physical activity, specifically organized sports. This will be categorized into two groups: school based physical activities and non-school-based physical activities. School based physical activities will divided into two sections, including a section on involvement in intramural or house league teams and a section on school sports team. Both groups will have scores ranging from 0-5 (5 being the most active choices), and the non-school based physical activities will be defined as "participation in sports teams, outside of school, sports and dance clubs, and sports and dance lessons," with scores ranging from 0-15 (15 being the

most active choices).

3.3.4 *Sedentary Behaviours*

There is also an area on the PQ that reports television watching and reading books. Participants recorded how often they watch television and how many hours per day. Respondents reported the number of hours they watch TV by choosing: watching TV an average of 0-2 hrs/day, between 2-4 hrs/day, greater than 4 hrs/day. They also recorded often they watch TV and responses ranged from every day to never. The same protocol will be used for reading books.

3.4 Assessment of Leisure Time Exercise (Intensity and Duration)

Leisure time exercise was determined for all subjects using the Godin-Shephard Leisure-Time Exercise Questionnaire. This scale was designed as a reliable, valid and easy to complete evaluation of activity without the need for detailed review (Godin-Shephard, 1985). This can be used to monitor the impact of health and physical fitness promotion programs in the community. It requires that students consider over a 7-day period, how many times on average they have certain kinds of exercise for more than 15 minutes during their free time. There are three classes of exercise that need to be completed, included the number of times for strenuous exercise (heart beats rapidly), moderate exercise (not exhausting), and mild exercise (minimal effort). Strenuous exercise (9 METS) includes activities such as; running, jogging, hockey, football, soccer, squash, basketball, and cross country skiing, judo, roller, skating, vigorous swimming, and vigorous long distance bicycling. Moderate exercise (5 METS) involves: fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular, and folk dancing. Mild exercise (3 METS) is activities such as: yoga, archery,

fishing from riverbank, bowling, horseshoes, golf, and snow mobiling, and easy walking. Activity score in arbitrary units are then calculated for each subject with the formula: Activity Score = (9 * (number of strenuous exercise episodes)) + (5 * (number of moderate exercise episodes)) + (3 * (number of mild exercise episodes)) (Godin & Shephard, 1985). The 2-week test–retest reliability of the measures of total leisure activity and the frequency of activity that works up a sweat have been estimated to be 0.74 and 0.80, respectively (Motl, McAuley & DiStefano, 2004). An overall total high score on the GS reflects a high level of leisure exercise involvement. The final score was obtained in accordance to the methodology described by Sallis et al. by multiplying the frequencies of each activity by its MET score and summing the product. The resulting score is in arbitrary units. Subjects may be classified with or without the risk factor of low physical activity index when they are below the percentile 25 ($\leq$P25) of PAI or above the P25 of PAI (>P25), adjusted to age and sex (Ribeiro, Guerra, Oliveira, Teixeira-Pinto, Twisk, Duarte & Mota, 2004).

3.5 Anthropometric Variables

Participants had their height and weight measured to the nearest 0.1 cm with a medical scale-stadiometer. Children wore their physical education clothes, with shoes removed. Body mass index was calculated from these values (weight (kg)/height (m^2)). Research assistants to the nearest 0.1 cm also measured waist circumference.

3.6 Definition of Obesity

This study defined childhood obesity according to the age-adjusted cut-offs developed by Cole et al. (2000). On the basis of BMI, the children will be grouped as normal weight (boys: <20.6-21.2; girls: <20.7-21.7) overweight (boys: $\geq$ 20.6-21.2 and <25.1-26.0;

girls: ≥ 20.7-21.7and <25.4-26.7), or obese (boys: ≥ 25.1-26.0; girls: ≥25.4-26.7). This definition has high diagnostic specificity (low false positive rate).

3.7 Parental Questionnaire (Measure of Covariates)

The parental questionnaire was a 63-item survey that collected data from parents on different variables such as cultural background and socioeconomic status (Appendix E). This questionnaire was developed from established scales such as the National Population Health Survey, which is the part this study will focus on (Statistics Canada, 1998). Cultural background was obtained but it will not be taken into account because of the homogeneous nature of the participants. The highest level of parental education obtained was recorded on the Parental Questionnaire. This will be used as a proxy measure of the child's socioeconomic status (SES).

3.8 Statistical Analyses

3.8.1 *Descriptive Statistics*

Descriptive statistics will examine the distribution and characterization of the variables in numerical format and present the data as mean +/- standard deviation or as a proportion. Groups will be divided by gender, and various characteristics will be presented and student's t-tests and χ^2 tests will explore this relationship. Statistical significance will be set at a level of $p<0.05$.

3.8.2 *Testing for Motor Proficiency Stability*

The data of the 89 individuals from the five schools that were tested for MP on two separate occasions 12 -24 months apart will be compared. Significance and the correlations between these values will be determined using a general linear regression.

3.8.3 *Examining the Relationship between Motor Proficiency and Body Composition*

Chi-square tests of independence will explore the relationship between motor proficiency and body composition. Also, Chi-square tests of independence, and ANOVAs will determine the relationships between motor proficiency and body composition and physical activity behaviours. Values will be displayed as percentages to total 100% in their column.

3.8.4 *Testing the Main Research Objective*

To answer the main research question: What is the influence of physical activity behaviour on the relationship between motor proficiency and body composition in childhood? The association of predictors with body composition classified in to three groups (dependent categorical variable) will be examined by multivariate ordinal logistic regression analysis. Dummy variables will be created for the physical activity behaviours that are categorical, with the least amount of time spent on sedentary activity and the greater amount of time spent on an active category used as a reference group. Ordinal logistic regression (OLR) analysis (using a cumulative odds model) of body composition on physical activity behaviours will be performed separately for each physical activity pattern, and then assessed controlling for motor proficiency, gender and age. Finally, the model will be examined with inclusion of all physical activity behaviours and a parsimonious model will be created. The variance inflation factor will be used to look for multi-collinearity between variables in the model and variables that have a variation inflation value of greater than 10 will be investigated further. Also, variables will be dropped from the final model if they cause the standard error values to be too high. A

final adjusted cumulative odds model for obese and overweight/obese (adjusted for motor proficiency, age and gender) will be presented for physical activity measures that had an adequate variation inflation value and if they were found to significant in the individual models or in previous literature. This analysis will allow us to study the research question of determining what degree motor proficiency and physical activity behaviours influence body composition.

Ordinal logistic regression (OLR) will be used, as it is sensitive to differences across levels of body composition and does not make parametric assumptions regarding the metric distance between outcome levels. Despite being a non-parametric test of association, OLR still possesses the ability to determine linearity of effect as well as produce effect estimates, however caution must be taken when interpreting the coefficients due to the nature of the iterative algorithm employed with maximum likelihood estimation (Allison, 1999). A cumulative odds assumption will be the type of ordinal logistic regression employed. It mimics the method of dichotomizing the outcome, in which the successive dichotomizations create cumulative "splits" for the data. This method allows us to examine how the data may be sequentially partitioned into dichotomous groups, while continuing to take advantage of the order that the response variables fall in. This analysis is appealing, as it is very similar to logistic regression. In this method, the cumulative odds model is used to predict the odds if being at or beyond a particular category (the odds over being obese or overweight and obese). The overall goal of this model is to consider the effects of independent variables across the possible cumulative splits to the data (O'Connell, 2006). All data will be analyzed using SAS Statistical software v9.1 (SAS Institute, Cary, NC).

Chaper IV: Results

4.1 Sample Characteristics

Out of the original 2260 individuals with available data from the PHAST study, a total of 1287 children (646 males and 641 females) with complete PHAST id's, motor proficiency, and body composition data were included in the final analysis.

Sample characteristics by gender are summarized in Table 5. Overall, the only significant differences between males and females were height (151.0 $\pm$ 7.2 cm vs. 152.3 $\pm$ 7.4 cm, p=0.001), motor proficiency (71.3 $\pm$ 29.3 percentile vs. 65.1 $\pm$ 29.4 percentile, p=0.0002) and the Godin-Shephard leisure exercise measurement (80.1 $\pm$ 56.2 vs. 71.9 $\pm$ 58.6, p=0.01).

The differences in sample characteristics among various motor proficiency groups are shown in Table 6. Significant differences were observed between the case group, borderline case and non-case group in weight (kg) (54.7 $\pm$ 16.9 vs. 51.7 $\pm$ 13.2 vs. 45.7 $\pm$ 11.1), BMI (kg/m^2) (23.3 $\pm$ 5.6 vs. 22.2 $\pm$ 4.8 vs. 19.7 $\pm$ 3.7), and waist circumference (cm) (78.0 $\pm$ 14.7 vs. 78.1 $\pm$ 12.6 vs. 70.7 $\pm$ 10.6). As expected, the prevalence of being classified as overweight was higher in the case group and borderline case group. Approximately 28.8% of case group children and 31.3% of borderline case group individuals were classified as overweight, compared to only 21.5% of the non-case group individuals. Also, a greater percentage of children in the case group and borderline case group were considered to be obese compared to their peers (30.1 vs. 22.9 vs. 8.2). There were also significant differences between free-time activity (activity units (au)) (13.4 $\pm$ 5.7 vs. 16.4 $\pm$ 7.1 vs. 18.5 $\pm$ 7.3) and SES (3.7 $\pm$ 1.8 vs. 3.7 $\pm$ 1.8 vs. 4.2 $\pm$ 1.7) among the

groups. There were no significant differences among gender, age or height in the different motor proficiency groups.

4.2 Motor Proficiency Stability

When observing the correlations between the 89 individuals that had their motor proficiency tested two separate occasions between 12-24 months apart, a moderate to good relationship was found ($r=0.70$, $p<0.01$).

4.3 Physical Activity Characteristics and Motor Proficiency

Physical activity characteristics (active and inactive pursuits) according to motor proficiency are presented in Table 7. Significant differences ($p<0.05$) were observed between the case group, borderline case group and non-case group for the sedentary variables; T.V watching (13.9 vs. 10.4 vs. 5.7, >4hrs/day), reading books everyday (22.2 vs. 8.3 vs. 15.9), reading books (8.3 vs. 2.1 vs. 1.2, >4hrs/day), and inactivity (9.7 ± 3.0 vs. 8.8 ± 3.5 vs. 8.1 ± 3.3). In general, there was a trend of a greater involvement in sedentary activities in the case group compared to the non-case group. There were also significant differences prevalent in the Godin-Shephard leisure exercise measurement (METS) (64.5 ± 59.4 vs. 59.1 ± 29.5 vs. 77.5 ± 58.1, $p=0.02$) and school sports teams (1.6 ± 0.99 vs. 1.9 ± 0.6 vs. 2.2 ± 1.1, $p=0.03$). It is evident that the non-case group had higher physical activity values, and lower sedentary values compared to the case-group. There were no statistical differences between motor proficiency groups for free-time activity, school intramurals, or non-school based activities.

4.4 Physical Activity Characteristics and Body Composition

The relationship between physical activity characteristics (active and inactive pursuits) and body composition are presented in Table 8. Individuals in the normal

weight category had a greater participation in school sports teams compared to children in the obese group (2.2 $\pm$ 1.1 vs. 1.9 $\pm$ 1.0, p=0.0008). There were no significant differences between free-time activity, T.V watching, reading books, school intramurals, non-school based activities, Godin-Shephard lesuire exercise or inactivity scores between the different body composition groups.

4.5 Multivariate Ordinal Logistic Regression Results

The results for the multivariate ordinal logistic regression analyses are presented in Tables 9-21. When separate logistic regressions were performed for each physical activity behaviour, school intramurals and school sports teams were both significantly associated with body composition.

Participation in an increased number of school intramurals was significantly associated with body composition in the unadjusted model (Tables 14). Children who participate in more school intramurals are at a decreased risk of being in the obese or overweight/obese category (unadjusted model, OR: 0.86, CI: 0.75-0.99). However in the adjusted model, this variable was no longer significant.

Both the unadjusted and the adjusted models for involvement in school sports teams was significantly related to being in the obese or overweight/obese category. Individuals who were involved in a greater number of school sports teams were less likely to fall in a higher BMI grouping (adjusted model, OR: 0.80, CI: 0.69-0.93).

The other physical activity behaviour variables studied, including; free-time activity, T.V watching (hrs/day and frequency), reading books (hrs/day and frequency), non-school based activity, leisure exercise and inactivity score were not significantly associated with body composition in either the unadjusted or adjusted models.

In the fully adjusted final model, when all significant variables from the separate models, as well as any variables shown to be significant in previous studies were added, only school sports teams remained significant (Table 21). Individuals involved in a greater number of school sports teams had decreased odds of in being in a higher BMI category (OR: 0.67, 95% CI: 0.49-0.93).

Among the control variables, both motor proficiency level and gender were significant in the fully adjusted model (Table 21). Children in the case group were approximately 10.9 times (95% CI:1.83-64.78) more likely to be obese or overweight/obese compared to those in the non-case group. Also, females were 2.1 times (95% CI:1.17-3.80) more likely than males be in a higher BMI grouping. An interaction between free-time activity and motor proficiency was tested, and school-based activities (intramurals and sports teams) and motor proficiency was tested, however these relationships were not significant. Also, age was not significantly related with body composition in children.

Chapter V: Discussion

The main objective of this study was to examine the relationship among motor proficiency, and overweight/obesity, and estimate the influence of physical activity behaviours on this association.

5.1 Physical Activity and Motor Proficiency

The results revealed that individuals in the case group (n = 74) are more likely to be obese compared to children in the non-case group (n = 1165) (30.1% vs. 8.2%, $p<0.0001$), which is consistent with previous studies (Cariney et al., 2007). It has been suggested that children with low motor proficiency have lower perceptions of their physical abilities, and therefore are more inactive, which may lead to the development of overweight (Wrotniak, Epstein, Dorn, Jones & Kondilis, 2006). Our findings support this view, and it was found that children with low motor proficiency had a greater involvement in sedentary behaviours such as; T.V watching, reading books, and inactivity measures, and a lower participation in active categories including; school sports teams, and leisure exercise.

5.2 Physical Activity Characteristics and Body Composition

There are many contradicting studies on whether children with low motor proficiency are at risk for being overweight as a result of lower levels of activity, since it is very difficult to determine if physical activity greatly differs in normal weight versus overweight children (Mota et al., 2006). From the energy balance view, it would be predicted that there would be an association between physical activity levels and obesity in children (Rowlands, Eston & Ingledew, 1999). We failed to observe significant

differences between normal weight and obese children when focusing on the majority of physical activity evaluations including; T.V watching, reading books, inactivity and leisure exercise, with the exception of school sports teams.

5.2.1 *School Sports Teams*

The normal weight group participated in a greater number of school sports teams compared to the obese group (2.2 vs. 1.9, p=0.0008). In contrast, our study found that there was no significant difference between non-school based activities or free-time activity among the various body composition groups. These results however, may be due to the inability to adjust for socioeconomic status. Our results contradict a previous study that found free-time activities are lower in overweight children, compared to structured types of activity such as school based recreation in which weight does not play a factor in participation (Mota, Santos & Gomes, 2006). Perhaps, children within a normal weight range may feel more confident in trying out for a school sports team, and children who fall into an overweight category may have less confidence in their athletic abilities. School sports clubs may also be too competitive, and therefore keep out the less-fit children and adolescents, including the overweight and obese (Deforche, Lefevre, DeBourdeaudhuij, Hills, Daquet & Bouckaert, 2003).

The present study also demonstrated in the final fully-adjusted logistic regression model that participation in a greater number of school sports teams lowered a child's risk of being obese overweight/obese (OR: 0.67, 95% CI: 0.49-0.93). This seems logical because school sports teams tend to be very competitive due to the fact that typical teams including basketball and volleyball only have approximately 12 players. This would likely lead to coaches selecting individuals that are more fit and more physically active in

other aspects of their life. Therefore, children who are on a greater number of sports teams would be at a lowered risk of being in a higher BMI grouping because they are most likely very athletic.

5.2.2 *School Intramurals*

It was demonstrated that involvement in a greater number of school intramurals lowered a child's risk of being obese or overweight/obese in the unadjusted model (OR:0.86, 95% CI: 0.75-0.99). School intramural and club programs in middle school have not been studied extensively, nonetheless, the link between school based activity and body composition seems reasonable because children spend more time in schools than any other setting with the exception of being at home (Pate, Davis, Robinson, Stone, McKenzie & Young, 2006). If individuals are going to participate in an adequate amount of physical activity, it is imperative for schools to effectively promote and provide individuals with programs that allow this during school-time. It has been suggested by Hay (1992) that children take part in physical activities to the extent that they view themselves capable of enjoyable participation in those activities. Therefore, when children are able to freely select the type of activity without the pressure from their parents, they may be more likely to be physically active. This may be the case for school based participation, when the child can independently get involved with an intramural program without the pressure from their parents or other peers.

This suggests that increasing or promoting school-based activities in an educational institution may be an effective concept for keeping children within a healthy weight-range. Also, if schools allowed for practices with children that did not make the school sports teams this would include individuals that would not likely have been given an

opportunity to be involved in the past, specifically children with low motor abilities.

5.2.3 *Non-School Based Activities*

Due to the fact that an increase participation in school based activities is related to a healthier BMI, one could argue that after-school programs or non-school based activities would display a similar relationship. However, this study failed to observe a significant association between non-school based activities or free-time activity with body composition. These results are similar to studies that have failed to find a relationship between free-time activities and obesity, and concluded that it's difficult to demonstrate that overall physical activity levels are linked to excess body fat during childhood (Mota et al., 2006). Although non-school based programs and free-time activities have a large potential to enable increased physical activity, data has not yet shown that these types of participation increase overall physical activity, lower body weight, or lead to greater health benefits (Pate et al., 2006). It is uncertain whether children compensate after this type of activity by being less active for the remainder of the day or during other days of the week.

5.2.4 *Sedentary Activities*

It had been suggested that reducing sedentary activities may play a role in increasing physical activity in children, in turn allowing them to achieve/maintain a healthy weight. There is evidence that an increasing amount of time is being devoted to sedentary pursuits, and this results in competition with physically activity. Also, time that was once spent outside during free-time activity is now spent indoors. However, experimental data does not fully support a direct link between sedentary activities and physical activity (Mota, Gomes, Aleida, Ribeiro, & Santos, 2007). In general, studies

that concentrate on the association between physical activity and screen-time are mixed.

According to Marshall, Biddle, Gorely, Cameron & Murdey (2004) there is a statistically significant relationship between TV viewing and body fatness among children, however their sample size was too small to be clinically relevant. Similarly, a five-yr longitudinal study of 138 obese Pima Indian children found that obesity at baseline was related to a decreased participation in sports and a greater amount of television viewing, but not with physical activity (Salbe et al., 2002). These results suggest that a decrease in activity follows rather than precedes the development of obesity.

In contrast, many other studies have been unable to demonstrate that there is an association between television viewing and obesity. Mota et al. (2006) failed to show significant differences between BMI groups and time spent watching T.V during weekdays and weekends. The present study found that the relationship between T.V watching (frequency and hrs/day) and BMI category was not statistically significant. Nonetheless, it has been suggested that children who spend a lot of time watching television may have different snacking patterns and food consumption (Slyper, 2004). Television advertising tends to promote foods that are higher in calories and nutrient poor, and children may be influenced by this (Berkey et al., 2000).

5.3 Motor Proficiency and Body Composition

A significant relationship between the case-group with low motor proficiency and BMI category was also observed. Individuals in this group were approximately 11 times more likely to be in a higher BMI category (OR: 10.91, 95% CI: 1.8-64.8). These findings are consistent with research that found a poorer body motor development

increases a child's chance of being overweight/obese (Graf, Koch & Kretshmann-Kantel, 2004). Children who lack sufficient motor competence skills are less likely to be physically active, compared to children without this condition (Cairney et al., 2006). This deficit is most likely caused by a lack of self-efficacy regarding the child's physical abilities. A predilection for sedentary activities and an avoidance of structured PA opportunities is most likely a way to deal with the possible outcome of failure and humiliation they may face (Cairney et al., 2005). There is still a strong relationship between motor proficiency and BMI risk despite adjusting for physical activity behaviours in our study. Therefore, motor proficiency is a concern worthy of further research, because of the likelihood of being overweight and the many problems associated with this condition.

5.4 Gender and Body Composition

A significant relationship between gender and body composition was also displayed in the final fully adjusted model. Girls were at an increased risk of being in a higher body composition category compared to boys (OR: 2.10, 95% CI: 1.17-3.80). It has been suggested that females have lower total energy expenditure than boys and this may explain their greater susceptibility to a higher weight (Sawaya, Dallal, & Solymos, 1995). Also, according to Hoffman, Sawaya, Coward, Wright, Martins, Nascimento, Yucker & Roberts (2000) girls devote less time to intensely vigorous games (soccer), but the underlying cause of this difference is unknown.

5.5 Study Limitations

There are several limitations that should be addressed for this study. Firstly, there is the possibility of self-reporting bias with the Participation Questionnaire and the

Godin-Shephard leisure time questionnaire. However, self-report data may still be useful in providing a crude estimate of the amount of time exhausted during various types of physical activity and it is a quick and simple method to collect data on the participants' physical activity levels. A further limitation of this study is that the results are not generalizable to other age groups or some geographical regions. However, the results of this study are representative of the general population of Canadian children because the Niagara Region is not markedly different from other areas of the country. Another limitation of this research is that there are many other factors associated with physical activity behaviours not considered, such as energy intake and genetic predisposition. However, physical activity behaviours are believed to have the strongest association in the trajectory of weight gain. Not only is it directly related to the development of obesity, but it also indirectly affects the many other variables which also play a role in body composition. Also, this study was unable to distinguish between or adjust for schools that had a greater involvement or availability of intramural programs. This depended on the size of the school and number of teachers with a physical education background. Therefore, school intramural involvement opportunities most likely differed across the schools. In addition, the cross-sectional design of this study does not allow us to infer a causal relationship between physical activity characteristics and overweight/obesity. Lastly, the results were not adjusted for socioeconomic status due to the fact that the sample size would have been too small and it would have reduced the power of this study.

Chapter VI: Conclusions

6.1 Conclusions

These findings confirm that children with low motor proficiency are at significant risk of being overweight/obese compared to their peers. It is evident that these children have generally attenuated activity levels with greater time spent in sedentary pursuits. Children with poor motor proficiency reported less participation in school activities (intramurals/ school sports teams). School programs are one area where children have near autonomy in their participation and therefore may be most indicative of future activity patterns and may be seen as possible targets for modification to promote activity and a lower BMI in general.

The finding that normal weight children report higher participation in organized school-sports (inter-school teams), compared to their peers supports this view. Widening activity opportunities during school time may allow more occasions for children to select active pursuits and achieve a healthy weight. Furthermore, the promotion of school-based programs, specifically intramural sports may be an important aspect in increasing children's overall activity levels.

It is essential to consider the needs of those children with low motor proficiency in developing programs to encourage physical activity, and to further explore the relationship between motor proficiency and overweight/obesity. This research will help shed light on this very complex issue.

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Figures

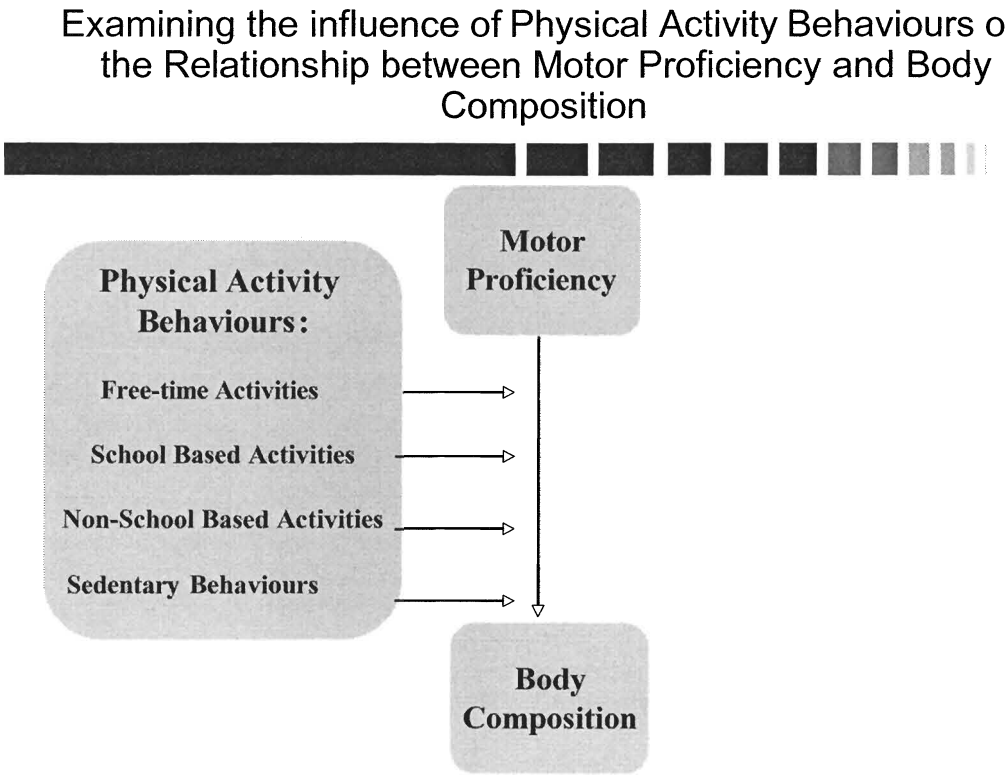


Figure 1: Flow chart of research aim.

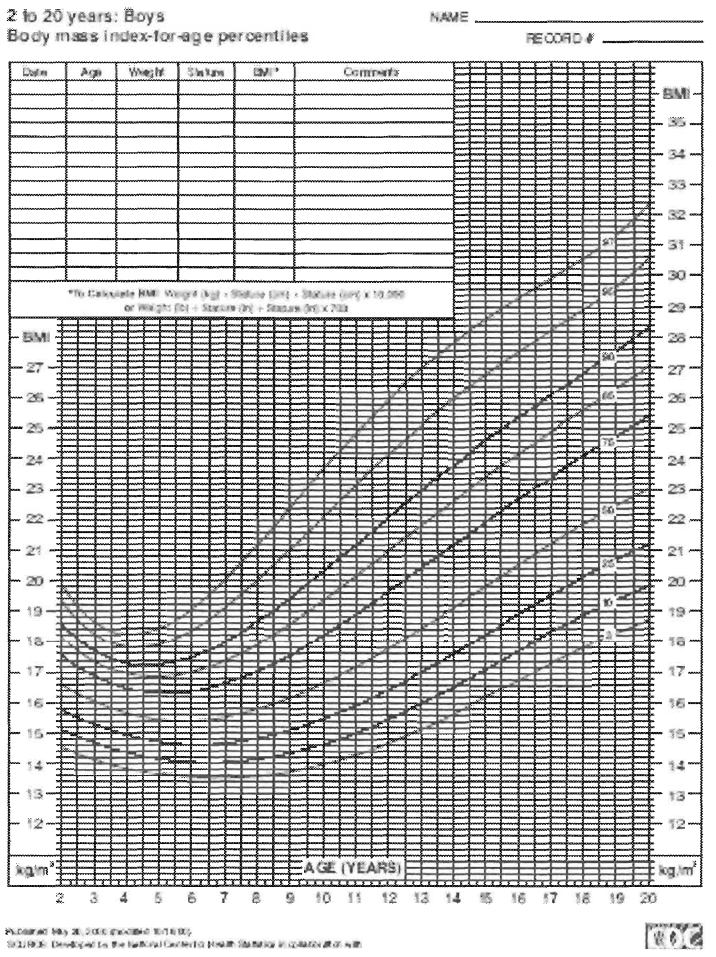


Figure 2: CDC Growth Charts: United States (Cole et al., 2000)

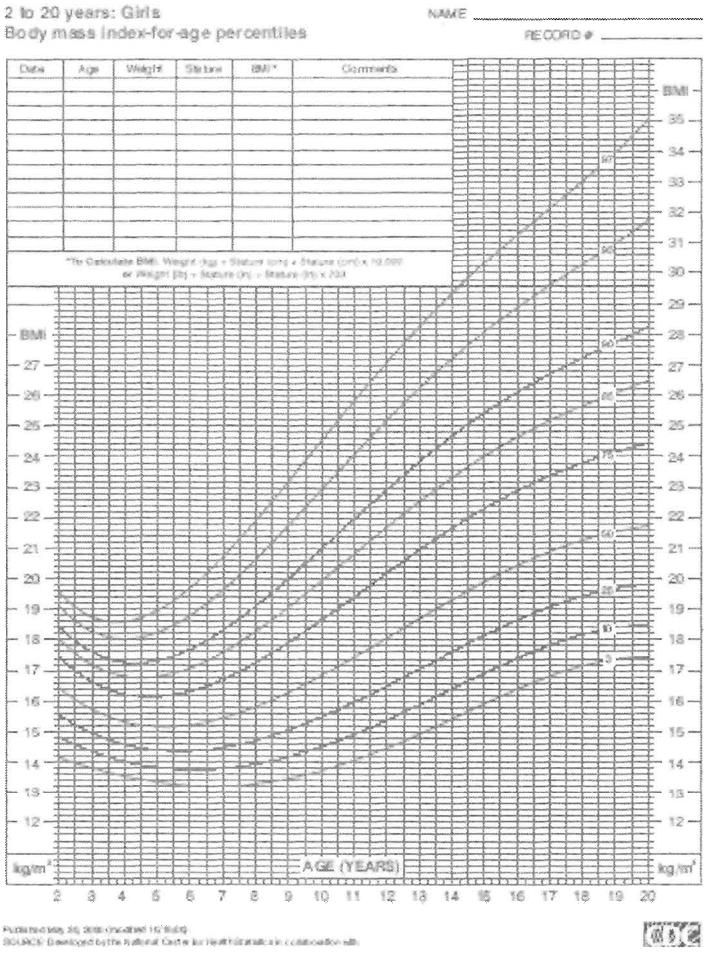


Figure 3: CDC Growth Charts: United States (Cole et al., 2000)

Tables

Table 1: BMI-for-age weight status categories and the corresponding percentiles

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy Weight	5th percentile to less than the 85th percentile
At risk of overweight	85th percentile to less than the 95th percentile
Overweight	Equal to or greater than the 95th percentile

(Division of Nutrition and Physical Activity, National Center for Chronic Disease Prevention and Health Promotion)

Table 2: WHO standard classification of obesity

	BMI	**Risk of co-morbidities**
NORMAL BMI	18.5-24.9	Average
OVERWEIGHT:		
Pre-Obese	25.0-29.9	Increased
Obesity class I	30.0-34.9	Moderate
Obesity class II	35.0-39.9	Severe
Obesity class III	$\geq$ 40.0	Very-severe

(WHO, 1998)

Table 3: Cut-off points for body mass index for overweight and obesity by sex between 11 and 12 years of age.

	Overweight		Obese	
Age (years)	Boys	Girls	Boys	Girls
11	20.6	20.7	25.1	25.4
11.5	20.9	21.2	25.6	26.1
12	21.2	21.7	26.0	26.7

(Cole et al., 2000)

Table 4: The samples sizes included for each variable considered and the year of PHAST testing the data was collected.

Variables Considered	**Year 1 (2004) Subject Numbers**	**Year 2 (2005) Subject Numbers**	**Year 3 (2006) Subject Numbers**
Movement Skills Appraisal (BOTMP-SF)	424 (213 males, 211 females)	428 (213 males, 215 females)	435 (220 males, 215 females)
Physical Activity Questionnaires (PQ)			1267 (632 males, 635 females)*
Anthropometric Testing			1287 (646 males, 641 females)

* Values missing

Table 5: Sample characteristics by gender

Variable	Males (n=646)*	Females (n=641)*	p-value
Age (yrs)	11.4 ± 0.5	11.3 ± 0.5	0.25
Weight (kg)	45.9 ±11.6	47.1 ± 12.0	0.06
Height (cm)	151.0 ± 7.2	152.3 ± 7.4	0.001**
BMI (kg/m^2)	19.9 ± 4.0	20.1 ± 4.1	0.38
Obese (%)	9.9	9.9	0.77
Waist Circum. (cm)	71.4 ± 10.9	71.8 ± 11.1	0.79
Motor Prof. Rank (percentile)	71.3 ± 29.3	65.1± 29.4	0.0002**
Case Group (%)	5.0	6.6	0.37
Free-time activity (au)**	11.8 ± 3.4	11.9 ± 3.1	0.56
SES	41 ± 1.7	4.2 ± 1.7	0.46
Godin-Shephard (METS)	80.1 ± 56.2	71.9 ± 58.6	0.01**

Data are mean values. *Values missing

**Differences significant at p<0.05.

au (activity units): total number of active choices during free-time.
(highest score of 20 is most active).

Table 6: Sample Characterisitics by Motor Proficiency

Variable	Case Group(n=74)*	Borderline Case(n=48)*	Non-Case (n=1165)*	p-value
Gender				
Boys(%)	56.7	45.8	49.2	0.37
Age (yrs)	11.4 ± 0.5	11.3 ± 0.5	11.4 ± 0.5	0.32
Weight (kg)	54.7 + 16.9	51.7 ± 13.2	45.7 ± 11.1	<0.0001
Height (cm)	151.8 + 8.1	151.9 ± 7.2	151.5 ± 7.2	0.73
Waist Circum. (cm)	78.0 ± 14.7	78.1 ± 12.6	70.7 ± 10.6	<0.0001
BMI (kg/m^2)	23.3 ± 5.6	22.2 ± 4.8	19.7 ± 3.7	<0.0001
Free-time Activity (au)	13.4 ± 5.7	16.4 ± 7.1	18.5 ± 7.3	<0.0001
SES	3.7 ± 1.8	3.7 ± 1.8	4.2 ± 1.7	0.01
Normal Weight (%)	41.4	44.8	70.3	<0.0001
Overweight (%)	28.8	31.3	21.5	<0.0001
Obese (%)	30.1	22.9	8.2	<0.0001

Data are mean values. Differences significant at p<0.05. *Values missing

Motor Proficiency: Case group, <10th BOTM-SF percentile, Borderline Case, > 10th and < 20th BOTM-SF percentile, Non-Case>20th BOTM-SF percentile.

Table 7: Active and Inactive Pursuits by Motor Proficiency

Variable	CG (N=74)*	BC(N=48)*	NC (N=1165)*	p-value
Free-time Activity (%):				0.33
Low	50	47.1	31.9	
Organized Sports:				
School Intramurals	1.8 ± 1,4	1.8 ± 1.0	2.2 ± 1.2	0.1
School Sports Teams	1.6 ± 0.99	1.9 ± 0.6	2.2 ± 1.1	0.03
Non school-based	4.2 ± 2.7	4.9 ± 1.9	5.2 ± 2.7	0.38
Godin-Shephard (METS)	64.5 ± 59.4	59.1 ± 29.5	77.5 ± 58.1	0.02
Inactivity	9.7 ± 3.0	8.8 ± 3.5	8.1 ± 3.3	0.04
T.V Watching (%):				0.05
Never/ Hardly Ever	13.9	18.8	18.8	
Almost Everyday	31.9	35.4	43.9	
Everyday	54.2	45.8	37.2	
T.V Watching (hrs/day):				0.0007
0-2	44.4	62.5	67.3	
2-4	41.7	27.1	27.0	
>4	13.9	10.4	5.7	
Reading Books (%) :				0.02
Never	2.8	8.3	13.0	
Hardly Ever	41.7	54.2	36.5	
Almost Everyday	33.3	29.2	34.6	
Everyday	22.2	8.3	15.9	
Reading Books (hrs/day):				0.0001
0-2	80.6	93.8	90.1	
2-4	11.1	4.2	8.7	
>4	8.3	2.1	1.2	

Data are mean values. Differences significant at $p<0.05$. *Values missing

Motor Proficiency: Case group, <10th BOTM-SF percentile, Borderline Case, ≥ 10th and ≤ 20th BOTM-SF percentile, Non-Case>20th BOTM-SF percentile.

Inactivity: Difference between highest possible free-time activity score and actual score.

Table 8: Active and Inactive Pursuits by Body Composition

Variable	NW (N=861)*	OW (N=287)*	OB (N=126)*	p-value
Free-time activity (%):				0.95
Low	33.1	32.7	35.1	
Organized Sports:				
School Intramurals	2.2 ± 1.3	1.9 ± 1.1	2.1 ± 1.0	0.11
School Sports Teams	2.2 ± 1.1	2.0 ± 1.0	1.9 ± 1.0	0.0008
Non school-based	5.2 ± 2.8	5.4 ± 2.3	4.4 ± 2.0	0.34
Godin-Shephard(METS)	77.1 ± 59.3	77.1 ± 59.6	67.3 ± 40.2	0.16
Inactivity	8.1 ± 3.2	8.0 ± 3.4	8.6 ± 3.5	0.56
T.V Watching (%):				0.17
Never/ Hardly Ever	36.5	24.2	11.7	
Almost Everyday	44.9	38.8	39.2	
Everyday	18.6	19.9	15.2	
T.V Watching (hrs/day):				0.2
0-2	68.1	61.9	60.0	
2-4	26.2	30.8	32.0	
>4	5.7	7.3	8.0	
Reading Books (%):				0.75
Never	12.2	12.2	12.8	
Hardly Ever	36.3	39.2	41.6	
Almost Everyday	35.7	32.9	28.0	
Everyday	15.8	15.7	17.6	
Reading Books (hrs/day):				0.18
0-2	90.2	87.4	92.0	
2-4	8.4	10.9	4.8	
>4	1.4	1.8	3.2	

Data are mean values. Differences significant at $p<0.05$. *Values missing

Body Composition: Normal Weight (NW), overweight (OW), and obese (OB).

Inactivity: Difference between highest possible free-time activity score and actual score.

Table 9: Cumulative Odds of being obese or overweight/ obese and cumulative probabilities for free-time activity and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	1.4(2.27)	-
$\alpha 1$	1.60(2.27)	-
Free-time Activity:		
Low	-0.52(2.27)	0.55(0.16-1.92)
Low-Mod	0.60(0.44)	1.67(0.52-5.40)
Mod-High	-0.16(0.22)	0.80(0.47-1.32)
High	ref	
Motor Proficiency:		
Case Group	0.84(0.29)**	7.9(3.7-16.8)**
Borderline Case	0.39(0.32)	4.8(2.0-12.5)
Non-Case	ref	
Gender:		
female	0.12(0.09)	1.3(0.89-1.86)
male	ref	
Age	-0.10(0.20)	0.90(0.62-1.32)
Model Fit[a]	x^2_7= 38.7 (p<0.0001)	
Score Test[b]	x^2_7 = 8.3 (p=0.31)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 10: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for TV watching (frequency) and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	0.14(1.44)	-
$\alpha 1$	1.67(1.44)	-
T.V Watching:		
Every day	0.13(0.28)	1.20(0.83-1.61)
Almost Ever day	-0.11(0.08)	0.91(0.62-1.30)
Hardly ever/Never	ref	
Motor Proficiency:		
Case Group	0.56(0.17)**	3.96(2.52-6.20)**
Borderline Case	0.25(0.20)	2.86(1.66-4.93)
Non-Case	ref	
Gender:		
female	0.01(0.13)	1.03(0.81-1.30)
male	ref	
Age	-0.15(0.13)	0.86(0.67-1.10)
Model Fit[a]	x^2_6= 50.13(p<0.0001)	
Score Test[b]	x^2_6 = 4.4 (p=0.62)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 11: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for TV watching (hrs.) and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	0.16(1.44)	-
$\alpha 1$	1.69(1.44)	-
T.V Watching (hrs):		
>4	0.09(0.16)	1.27(0.79-2.03)
2-4	-0.06(0.11)	1.24(0.95-1.61)
0-2	ref	
Motor Proficiency:		
Case Group	0.55(0.17)**	3.96(2.47-6.10)**
Borderline Case	0.26(0.20)	2.91(1.69-5.02)
Non-Case	ref	
Gender:		
female	0.01(0.06)	1.02(0.81-1.30)
male	ref	
Age	-0.15(0.13)	0.86(0.67-1.11)
Model Fit[a]	x^2_6=49.76(p<0.0001)	
Score Test[b]	x^2_6 = 3.96 (p=0.68)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 12: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for reading books (frequency) and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	0.20(1.44)	-
$\alpha 1$	1.72(1.43)	-
Reading Books:		
Every day	-0.0001(0.13)	0.90(0.57-1.41)
Almost Ever day	-0.16(0.10)	0.77(0.52-1.14)
Hardly ever	0.05(0.13)	0.95(0.65-1.39)
Never	ref	
Motor Proficiency:		
Case Group	0.59(0.17)**	4.10(2.61-6.43)**
Borderline Case	0.24(0.20)	2.89(1.68-4.99)
Non-Case	ref	
Gender:		
female	0.03(0.06)	1.05(0.83-1.34)
male	ref	
Age	-0.15(0.13)	0.86(0.67-1.10)
Model Fit[a]	$x^2_7 = 49.58 (p<0.0001)$	
Score Test[b]	$x^2_7 = 4.26 (p=0.75)$	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 13: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for reading books (hrs.) and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	0.21(1.46)	-
$\alpha 1$	1.73(1.46)	-
Reading Books (hrs):		
>4	0.11(0.30)	1.19(0.50-2.86)
2-4	-0.05(0.20)	1.01(0.95-0.67)
0-2	ref	
Motor Proficiency:		
Case Group	0.57(0.17)**	4.03(2.56-6.33)**
Borderline Case	0.25(0.20)	2.93(1.70-5.06)
Non-Case	ref	
Gender		
female	0.009(0.06)	1.02(0.81-1.30)
male	ref	
Age	-0.15(0.13)	0.86(0.67-1.11)
Model Fit[a]	x^2_6=46.92(p<0.0001)	
Score Test[b]	x^2_6 = 6.94 (p=0.33)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 14: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for number of school intramurals

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.04(0.20)	-
$\alpha 1$	-0.48(0.17)	-
School Intramurals	-0.15(0.07)**	0.86(0.75-0.99)**
Model Fit[a]	x^2_1= (p=0.04)	
Score Test[b]	x^2_1= (p=0.08)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 15: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for number of school intramurals and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-3.12(2.93)	-
$\alpha 1$	0.19(2.04)	-
School Intramurals	-0.02(0.05)	0.88(0.77-1.02)
Motor Proficiency:		
Case Group	0.72(0.29)**	4.60(2.10-10.04)**
Borderline Case	0.10(0.28)**	2.47(1.17-5.24)**
Non-Case	ref	
Gender:		
female	0.07(0.08)	1.15(0.82-1.60)
male	ref	
Age	0	0.99(0.70-1.42)
Model Fit[a]	x^2_5= 23.16 (p=0.0003)	
Score Test[b]	x^2_5= 7.97 (p=0.16)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 16: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for number of school sports teams

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-1.89(0.20)	-
$\alpha 1$	-0.31(0.17)	-
School Sports Teams	-0.26(0.08)**	0.76(0.66-0.89)**
Model Fit[a]	x^2_1=12.55 (p=0.004)	
Score Test[b]	x^2_1= 0.02(p=0.88)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 17: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for number of school sports teams and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	1.50(1.87)	-
$\alpha 1$	3.14(1.88)	-
School Sports Teams	-0.23(0.08)**	0.80(0.69-0.93)**
Motor Proficiency:		
Case Group	0.37(0.29)**	3.72(1.70-8.15)**
Borderline Case	0.56(0.29)**	4.50(2.07-9.79)**
Non-Case	ref	
Gender:		
female	0.07(0.08)	1.33(0.98-1.80)
male	ref	
Age	-0.24(0.16)	0.79(0.57-1.09)
Model Fit[a]	x^2_5= 40.58 (p<0.0001)	
Score Test[b]	x^2_5= 3.01 (p=0.70	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 18: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for number of non-school based activities and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-3.12(2.93)	-
$\alpha 1$	-1.67(2.93)	-
Non-School based	-0.02(0.05)	0.98(0.89-1.08)
Motor Proficiency:		
Case Group	0.03(0.41)	2.2(0.71-7.0)
Borderline Case	0.74(0.39)**	4.51(1.62-12.52)**
Non-Case	ref	
Gender:		
female	0.02(0.13)	1.05(0.64-1.72)
male	ref	
Age	0.12(0.25)	1.13(0.69-1.87)
Model Fit[a]	x^2_5= 10.81 (p=0.06)	
Score Test[b]	x^2_5= 35.31 (p<0.0001)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 19: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for the Godin-Shephard and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
α2	0.27(1.44)	-
α1	1.80(1.44)	-
Godin-Shephard (METS)	-0.0007(0.001)	1.0(1.0-1.001)
Motor Proficiency:		
Case Group	0.58(0.17)**	4.04(2.58-6.33)**
Borderline Case	0.24(0.20)	2.90(1.68-5.0)
Non-Case	ref	
Gender:		
female	0.005(0.06)	1.01(0.80-1.28)
male	ref	
Age	-0.16(0.13)	0.86(0.67-1.09)
Model Fit[a]	x^2_5= 47.13 (p<0.0001)	
Score Test[b]	x^2_5= 5.47 (p=0.36)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Table 20: Cumulative Odds of being obese or overweight/obese and cumulative probabilities for inactivity score and other explanatory variables*

Variable	b (se(b))	OR (95% CI)
α2	-0.25(2.23)	-
α1	1.20(2.24)	-
Inactivity	-0.003(0.03)	1.0(0.94-1.05)
Motor Proficiency:		
Case Group	0.85(0.29)**	7.81(3.66-16.66)**
Borderline Case	0.36(0.32)	4.77(1.93-11.79)
Non-Case	ref	
Gender		
female	0.12(0.09)	1.28(0.88-1.85)
male	ref	
Age	-0.08(0.19)	0.93(0.63-1.35)
Model Fit[a]	x^2_5= 35.75 (p<0.0001)	
Score Test[b]	x^2_5= 8.17 (p=0.15)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Inactivity: Difference between highest possible free-time activity score and actual score.

Table 21: Final Cumulative Odds Model of being obese or overweight/obese and cumulative probabilities for various explanatory variables*

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-1.56(3.67)	-
$\alpha 1$	0.15(3.67)	-
Free-time Activity (%):		
Low	-0.41(0.98)	0.76(0.06-10.25)
Low-Mod	0.87(0.73)	2.73(0.43-17.19)
Mod-High	-0.34(0.42)	0.82(0.40-1.66)
High	ref	
T.V Watching (%):		
Everyday	-0.22(0.23)	0.80(0.33-1.97)
Almost Everyday	0.22(0.20)	1.24(0.56-2.75)
Never/Hardly Ever	ref	
School Intramurals	-0.13(0.15)	0.88(0.66-1.17)
School Sports Teams	-0.40(0.98)**	0.67(0.49-0.93)**
Motor Proficiency:		
Case Group	1.37(0.73)**	10.91(1.83-64.78)**
Borderline Case	-0.34(0.73)	1.97(0.27-14.37)
Non-Case	ref	
Gender:		
female	0.37(0.15)**	2.10(1.17-3.80)**
male	ref	
Age	0.12(0.31)	1.12(0.61-2.09)
Model Fit[a]	x^2_{11}= 27.47 (p=0.004)	
Score Test[b]	x^2_{11}= 10.98 (p=0.44)	

* Adjusted for age, gender, motor proficiency (descending option)

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Appendix A

Overview of PHAST study

The physical health study (PHAST) of children is a longitudinal and comprehensive study that commenced in the fall of 2004. The multi-disciplinary team involved with the project from Brock University includes John Hay, John Cairney (adjunct), and Brent Faught of the Department of Community Health Sciences; Frances Owen of the Department of Child and Youth Studies; James Mandigo, of the Department of Physical Education and Kinesiology; Cheryl Missiuna from the school of Rehabilitation Sciences at McMaster University, and Ron Lopez from the DSBN.

The PHAST study is a three-year, wide-scale comprehensive study ultimately studying for motor incoordination. At the beginning of the study, 2245 students took part in fitness and body composition appraisals. They also completed three questionnaires about physical activity levels and each individual's self-perceptions of adequacy in predilection for physical activity, and self-esteem levels. A subsequent physical activity questionnaire was also included in Year 3 of the study. Each year starting when the DSBN child participants were in grade 4, they were tested two times (two waves) during fall and spring of the school year.

For the present cross-sectional study, Year 3, Wave 2 data was deemed the best data set to focus on because Movement Skill Appraisals for all participants' information was collected at this point on all 75 schools. The majority of the data utilized will be from Year 3, Wave 2 of the PHAST study, with the exception of the movement skills appraisals that were gathered from 25 different schools each year, over the 3 years. Research has found that children with motor proficiency are unlikely to outgrow their

condition (Cairney et al., 2006). Therefore, it is appropriate to assume that despite when participants were tested with the BOTMP-SF their motor proficiency classification will still be valid in Year 3, however this study will confirm this stability (Cairney et al., 2006).

Appendix B

PARTICIPATION QUESTIONNAIRE

Name: _____ Age: _____ years

Grade: _____ Do you take Physical Education classes? YES / NO

INSTRUCTIONS:
In this survey you will be asked about the activities that you do at school and in your spare time. There are no right or wrong answers because this is not a test! Just answer each question as best as you can remember. Please read each question carefully before you answer it. TO ANSWER A QUESTION, JUST CHECK (✓) YOUR ANSWER OR PRINT YOUR ANSWER IN THE SPACE PROVIDED. Only select one answer for each question.

The following is a sample question to practice.

SAMPLE QUESTION

1. How often do you eat an apple?

Never	Once a month	Once a week	(
θ	θ	θ	

SECTION 1: FREE TIME ACTIVITIES

This section asks questions about what you do during your free time. Some of the questions will be about recess, some about what you like to do after school, and others will be about what you do on weekends and holidays. Active games mean things like tag or skipping or playing catch.

1. During recess (or spares), do you spend most of your time:

Talk with my friends	Do school work	Play active games
❑	❑	❑

2. After school and before you eat supper, most of the time do you:

Watch television	Talk with my friends	Play active games	Play video games	Do other things (Specify below)
θ	θ	θ	θ	_____

3. After supper and before you go to bed, do you spend most of your time:

Watch television	Talk with my friends	Read books	Play active games	Do other things (Specify below)
θ	θ	θ	θ	_____

4. On weekends, do you spend most of your time:

Watch television	Read	Play active games	Play video games	Talk with my friends	Do other things (Specify below)
θ	θ	θ	θ	θ	_____

5. During your free time, what are the three (3) things you like to do the most?

1. _____ 2. _____ 3. _____

6. During the summer, how often do you ride a bike? (If you answer never, go to Question #8)

Never	Once a month	Once a week	Once a day	All the time
θ	θ	θ	θ	θ

7. When you finish riding your bike, do you usually feel:

Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

8. During the winter, how often do you go ice skating for fun? (If you answer never, go to Question #10)

Never	Once a month	Once a week	Once a day	All the time
θ	θ	θ	θ	θ

9. When you finish ice skating, do you usually feel:

Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

10. How often do you go swimming for fun during the summer? (If you answer never, go to Question #12)

Never	Once a month	Once a week	Once a day	All the time
θ	θ	θ	θ	θ

11. When you have finished swimming, do you usually feel:

Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

12. During the winter, how often do you go cross-country skiing? (If you answer never, go to Question #14)

Never	Once a month	Once a week	Once a day	All the time
θ	θ	θ	θ	θ

13. When you finish cross-country skiing, are you usually:

Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

14. If there are other activities that you do once a week or more, please list them below:

1. _____ 2. _____ 3. _____

15. How often do you watch television?

Every day	Almost every day	Hardly ever	Never
❑	❑	❑	❑

16. How many hours per day do you usually watch television?

0-1	1-2	2-3	3-4	4-5	5 or more
θ	θ	θ	θ	θ	θ

17. How often do you read a book in your free time?

Every day	Almost every day	Hardly ever	Never
❑	❑	❑	❑

18. How many hours a day do you usually read books?

0-1	1-2	2-3	3-4	4-5	5 or more
θ	θ	θ	θ	θ	θ

19. How often do you play video games in your spare time?

Every day	Almost every day	Hardly ever	Never
❑	❑	❑	❑

20. How often do you play active games with your friends after school?

0-1	1-2	2-3	3-4	4-5	5 or more
θ	θ	θ	θ	θ	θ

21. How often in a week do you play active games with your family?

Every day	Almost every day	Hardly ever	Never
❑	❑	❑	❑

22. When you are playing active games with your friends or family, how often do you play hard enough to breathe heavily or make your heart beat quickly?

Very often	Often	Sometimes	Hardly ever	Never
θ	θ	θ	θ	θ

23. If you have daily or weekly chores at home (cutting grass, shoveling snow, farm chores, paper route), please list them below.

1. _____ 2. _____ 3. _____

24. How do you usually get to school?

Walk	Ride a bike	Take the bus	Get a ride
❑	❑	❑	❑

25. How long does it take you to get to school?

0-15 minutes	15-45 minutes	more than 45 minutes
❑	❑	❑

26. How many older brothers do you have? _____

27. How many older sisters do you have? _____

28. How many younger brothers do you have? _____

29. How many younger sisters do you have? _____

SECTION 2: INTRAMURAL or HOUSE LEAGUE GAMES

. These are games like borden ball or volleyball that you play in teams at school. Only include active games. These do not include games you play in physical education classes, or recesses. **If you haven't played any intramural games this year, check this box ❑ and go directly to SECTION 3.**

30. How many different intramural (house-league) activities have you played <u>this school year</u>?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

(If you answered 0, please go directly to SECTION 3)

31. During your intramural games, how often did you have to work hard (breathing heavily, sweating, heart beating quickly):

Very often	Often	Sometimes	Hardly ever	Never
θ	θ	θ	θ	θ

32. After playing games in intramurals, are you usually:

Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

33. How many times a week, on average, do you play intramural games?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

34. How many hours each week do you think you spend playing intramural games at school?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

35. How many of your friends play intramural games?

Most of them	A few of them	None of them
❑	❑	❑

SECTION 3: SCHOOL SPORTS TEAMS

These questions are about school teams that play sports against teams from other schools. **If you don't play for any of your school's sports teams, check this box ❑ and go directly to SECTION 4.**

36. This school year, how many school sports teams have you belonged to?

0	1	2	3	4
θ	θ	θ	θ	θ

(If you answered 0, please go directly to SECTION 4)

37. After a game or practice, are you usually:

Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

38. During games or practices, did you have to work hard (breathing heavily, sweating, heart beating quickly):

Very often	Often	Sometimes	Hardly ever	Never
θ	θ	θ	θ	θ

39. How many hours per week do you usually spend in practices or games for school sports teams?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

40. How many of your friends play on school sports teams?

Most of them	A few of them	None of them
❑	❑	❑

SECTION 4: SPORTS TEAMS OUTSIDE OF SCHOOL

These are teams like hockey, ringette, soccer, and baseball in leagues that are not part of your school. **If you haven't played on any sports teams in the last year, check this box ❑ and go directly to SECTION 5.**

41. In the last <u>year</u>, how many sports teams have you played on?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

If you answered 0, go directly to SECTION 5)

42. How many times a week, on average, do you go to a practice or game?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

43. How many hours a week, on average, do you think you spend at practices and playing games for sports teams?

0	1	2	3	4	5 or more

θ θ θ θ θ θ

44. During games and practices, did you have to work hard (breathing heavily, sweating, heart beating quickly):

Very often	Often	Sometimes	Hardly ever	Never
θ	θ	θ	θ	θ

45. After a practice or game, did you usually feel:

Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

46. How many of your friends play on sports teams?

Most of them	A few of them	None of them
❑	❑	❑

SECTION 5: SPORTS AND DANCE CLUBS

These are clubs like gymnastics, martial arts (karate, judo, etc.), tennis, golf, swimming, horseback riding, and dance (jazz, ballet, and tap). It doesn't include groups like Cubs or Girl Guides or 4H. **If you didn't belong to any sports or dance clubs in the last year, check this box ❑ and go directly to SECTION 6**

47. In the last year, how many DANCE clubs have you belonged to?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

48. In the last year, how many SPORTS clubs did you belong to?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

49. How many times a week, on average, do you go to a sport or dance competition or practice?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

50. How many hours a week, on average, do you think you spend at sport or dance activities?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

51. During practices or competitions, how often did you have to work hard (breathing heavily, sweating, heart beating quickly):

Very often	Often	Sometimes	Hardly ever	Never
θ	θ	θ	θ	θ

52. How tired to you feel after a sport or dance competition or practice?

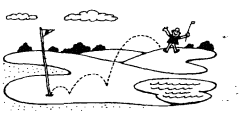
Very tired	Tired	A little tired	Not tired at all
❑	❑	❑	❑

53. How many of your friends belong to sports or dance clubs?

Most of them	A few of them	None of them
❑	❑	❑

SECTION 6: SPORTS AND DANCE LESSONS

This section asks questions about lessons that you took in the last year to learn things like swimming, tennis, golf, or dance. It also includes hockey schools. It doesn't include practices for teams or clubs. If you didn't take any sport or dance lesson in the last year, check this box ❑ and go directly to SECTION 7.



54. In the last year, how many different kinds of sports or dance lessons did you take?

0	1	2	3	4	5 or more

(If you answered 0, go directly to SECTION 7)

55. How many hours a week, on average, did you spend at sport or dance lessons?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

56. How many times a week did you go to a sport or dance lesson?

0	1	2	3	4	5 or more
θ	θ	θ	θ	θ	θ

57. How many of your friends take sport or dance lessons?

Most of them	A few of them	None of them
❑	❑	❑

58. During your sport or dance lessons, how often did you have to work hard (breathing heavily, sweating, and heart beating quickly):

Very often	Often	Sometimes	Hardly ever	Never
θ	θ	θ	θ	θ

SECTION 7: UNDERSTANDING YOUR BODY

This section asks questions that will help us learn how much you understand about your body composition.

59. I think I weigh _____ pounds.

60. I think I am _____ feet _____ inches tall.

61. Check the answer that best describes how you feel about your body.

Very underweight	Somewhat underweight	Just the right weight	Somewhat overweight	Very overweight
θ	θ	θ	θ	θ

62. Check the answer that best describes how you would change your body.

Lose a lot of weight	Lose a little weight	Stay the same	Gain a little weight	Gain a lot of weight
θ	θ	θ	θ	θ

63. Check the answer that best describes how you like the way your body looks.

A lot	A little	Not at all	Hate how I look
❑	❑	❑	❑

THANK YOU VERY MUCH FOR COMPLETING THE PARTICIPATION QUESTIONNAIRE! ☺

Appendix C

GODIN-SHEPHARD LEISURE-TIME EXERCISE QUESTIONNAIRE

1. Considering a **7-day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your **free-time** (write on each line the appropriate number)?
2. **Times Per Week**

(a) STRENUOUS EXERCISE
(HEART BEATS RAPIDLY)

_____
(i.e. running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)

(b) MODERATE EXERCISE
(NOT EXHAUSTING)

_____
(i.e. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

(c) MILD EXERCISE
(MINIMAL EFFORT)

_____
(i.e. yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

3. Considering a **7-day period** (a week), during your leisure-time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

1. OFTEN **2. SOMETIMES** **3. NEVER/RARELY**

4. Considering a **7-day period** (a week), during your leisure-time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

1. OFTEN **2. SOMETIMES** **3. NEVER/RARELY**

☐ ☐ ☐

Appendix D

Appendix 7 – The BOTMP-SF record form used in Canada 165

BRUININKS-OSERETSKY TEST OF MOTOR PROFICIENCY

INDIVIDUAL RECORD FORM
SHORT FORM

NAME _____ SEX: BOY ☐ GIRL ☐ GRADE ___
SCHOOL _____ EXAMINER _____

Arm Preference: *(circle one)*
RIGHT LEFT MIXED

Leg Preference: *(circle one)*
RIGHT LEFT MIXED

	Day	Month	Year
Date Tested	.....	.....	.....
Date of Birth	.....	.....	.....

Bioelectrical Impedance Analysis

HEIGHT: ..... RESISTANCE: ..... BODY FAT %: .....
WEIGHT: ..... REACTANCE: ..... SHUTTLE ST.: .....

	MAXIMUM SCORE	SUBJECT'S SCORE	STANDARD SCORE (Table 27)	PERCENTILE RANK (Table 27)	STANINE (Table 27)
SHORT FORM	99	_____	☐	☐	☐

Short Form:
1. During test administration, record subject's response for each trial.
2. After test administration, convert performance on each item (item raw score) to a point score using scale provided. For an item with more than one trial, choose best performance. Record item point score in square to right of scale.
3. Add point scores for all 14 items and record total in Test Score Summary section. Consult Examiner's Manual for norms tables.

Appendix 7 – The BOTMP-SF record form used in Canada 166

1. Running Speed and Agility

TRIAL 1: ..... seconds TRIAL 2: ..... seconds

Raw Score	Above 11.0	10.9-10.6	10.5-10.0	9.9-9.5	9.4-9.0	8.9-8.4	8.3-7.8	7.7-7.3	7.2-6.8	6.7-6.3	6.2-5.8	5.7-5.3	5.2-4.8	Below 4.8
Point Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13

2. Standing on Preferred Leg on Balance Beam *(10 seconds maximum per trial)*

TRIAL 1: ..... seconds TRIAL 2: ..... seconds

Raw Score	0	1-2	3-4	5-6	7-8	9	10
Point Score	0	1	2	3	4	5	6

3. Walking Forward Heel-to-Toe on Balance Beam *(6 steps maximum per trial)*

TRIAL ☐☐☐☐☐☐ 1: =..... steps TRIAL ☐☐☐☐☐☐ 2: =..... steps

Raw Score	0	1-3	4	5	6
Point Score	0	1	2	3	4

4. Tapping Feet Alternately While Making Circles with Fingers *(90 seconds maximum)*

Raw Score	Fail	Pass
Point Score	0	1

5. Jumping Up and Clapping Hands

TRIAL 1: ..... claps TRIAL 2: ..... claps

Raw Score	0	1	2	3	4	Above 4
Point Score	0	1	2	3	4	5

6. Standing Broad Jump *(record number from tape measure)*

TRIAL 1: ..... TRIAL 2: ..... TRIAL 3: .....

Raw Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Point Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

7. Catching a Tossed Ball with Both Hands *(5 trials)*

NUMBER OF CATCHES: .....

Raw Score	0	1-2	3-4	5
Point Score	0	1	2	3

8. Throwing a Ball at a Target with Preferred Hand *(5 trials)*

☐☐☐☐☐ = HITS

Raw Score	0	1-2	3-4	5
Point Score	0	1	2	3

9. Response Speed

	TRIAL	SECONDS TO WAIT	SCORE[1]	RANKED TRIAL SCORES[2]	
	Practice	1.....	1.....	XXXXX	
[1]Record number from response speed stick in this column.	Practice	2.....	3.....	XXXXX	
[2]Rank all seven trial scores highest to lowest in boxes provided. The point score for Subtest 6 is the median (middle), or fourth score from the top.		1.....	2.....	_____	HIGHEST
		2.....	3.....	_____	
		3.....	1.....	_____	
		4.....	3.....	_____	MEDIAN
		5.....	2.....	_____	
		6.....	1.....	_____	
		7.....	1.....		LOWEST

10. Drawing a Line Through a Straight Path with Preferred Hand

NUMBER OF ERRORS: .....

Raw Score	Above 6	6	2-5	1	0
Point Score	0	1	2	3	4

11. Copying a Circle with Preferred Hand

SCORE: .....

Raw Score	0	1	2
Point Score	0	1	2

12. Copying Overlapping Pencils with Preferred Hand

SCORE: .....

Raw Score	0	1	2
Point Score	0	1	2

13. Making Dots in Circles with Preferred Hand *(15 seconds)*

Raw Score	0	1-10	11-15	16-20	21-25	26-30	31-35	36-40	41-50	51-60	Above 60
Point Score	0	1	2	3	4	5	6	7	8	9	10

14. Sorting Shape Cards with Preferred Hand *(15 seconds)*

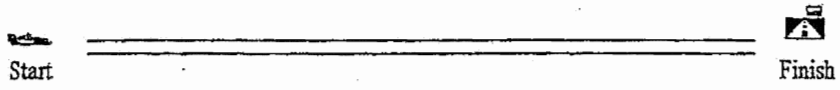
Raw Score	0	1-8	9-12	13-16	17-20	21-25	26-29	30-33	34-37	38-41	Above 41
Point Score	0	1	2	3	4	5	6	7	8	9	10

BIOELECTRICAL IMPEDANCE ANALYSIS

NOTES/OBSERVATIONS

Visual-Motor Control

Item 10: Drawing a Lint Through a Straight Path with Preferred Hand

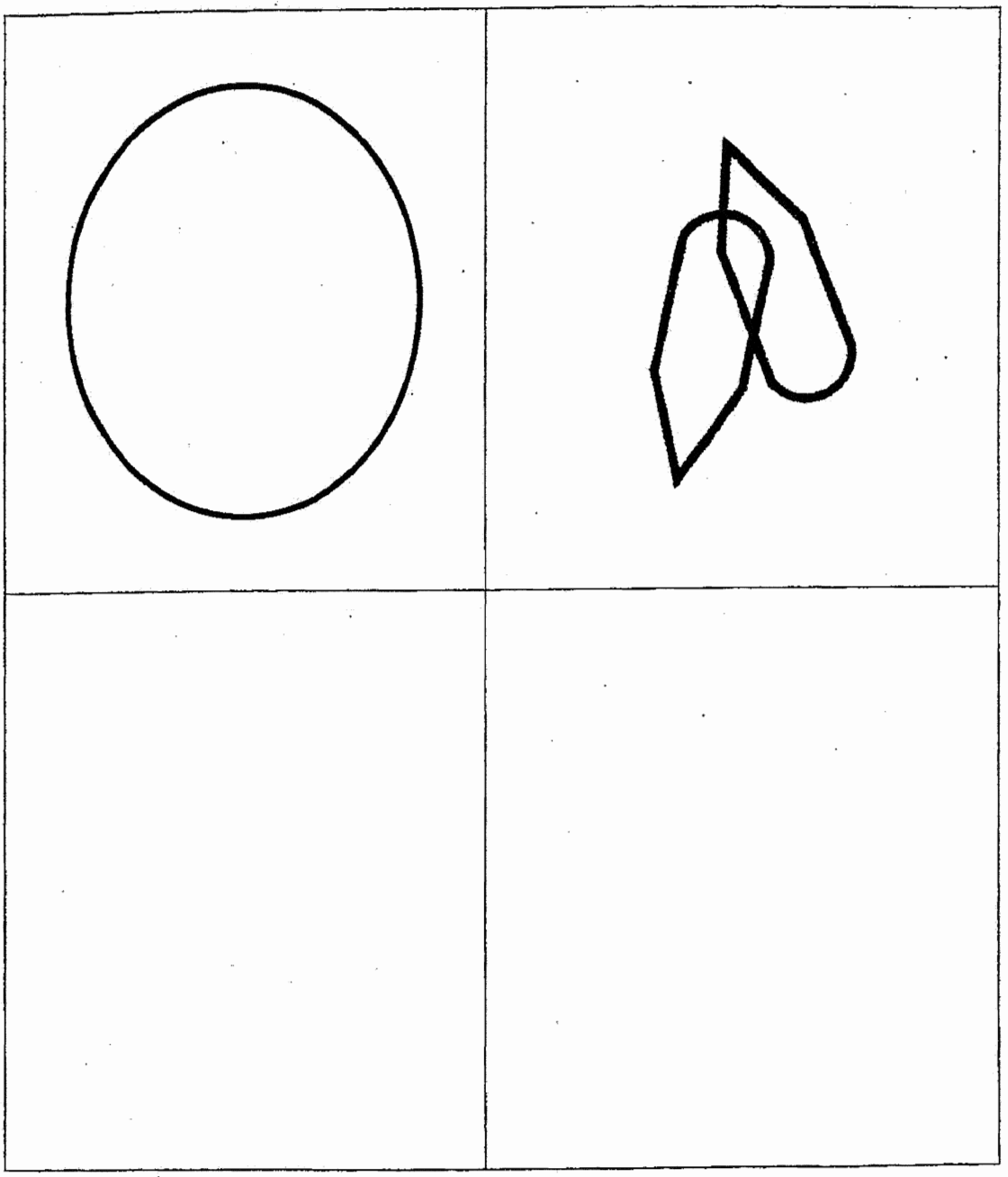


Number of Errors

Visual-Motor Control

Item 11: Copying a Circle with Preferred Hand

Item 12: Copying Overlapping Pencils with Preferred Hand



Score ____

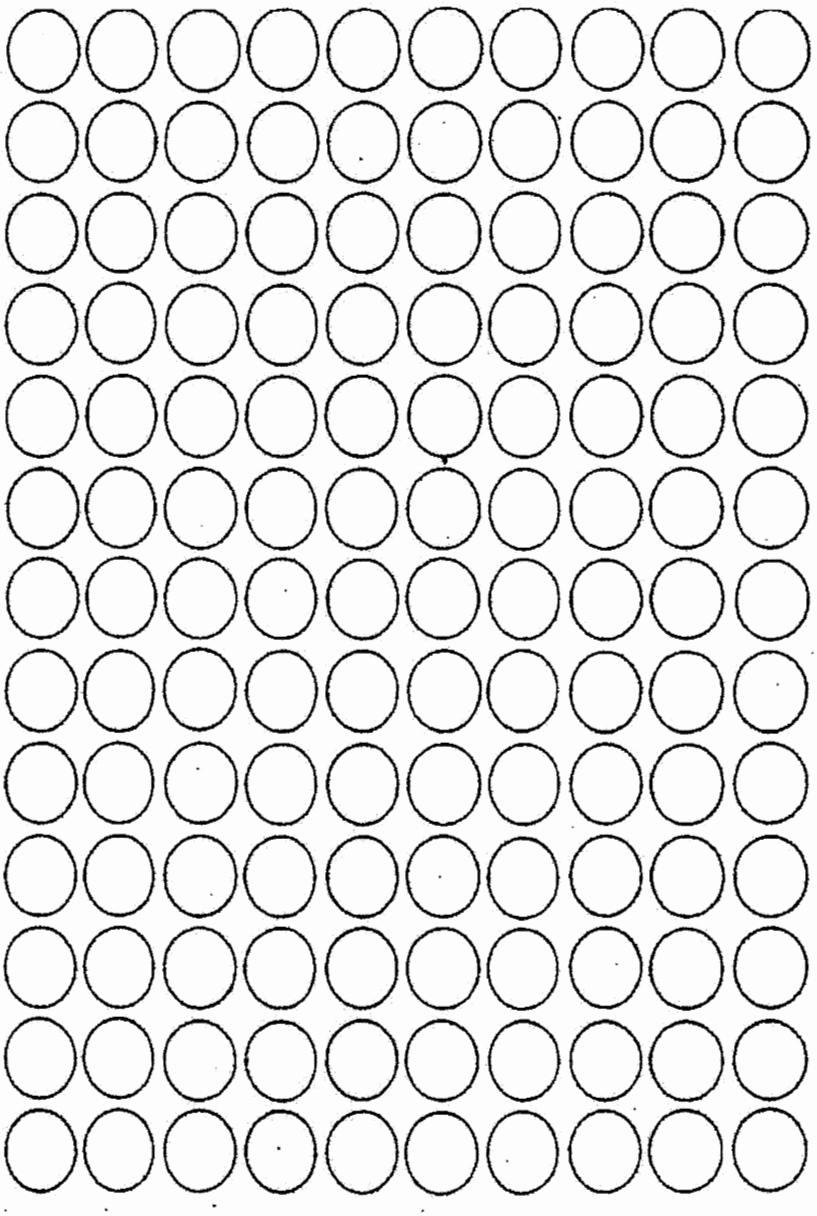
Score ____

Appendix 7 – The BOTMP-SF record form used in Canada 171

Upper-Limb Speed and Dexterity

Making Dots in Circles with Preferred Hand

Practice:



Number Correct

Appendix E

PARENT'S QUESTIONNAIRE

The following questions will give us an idea of how you spend your time with your children (starting with less active things), your thoughts about their activity levels, and the challenges you face regarding their physical activity. Some questions will let us compare your answers to similar parents – age, gender, type of residence, etc. We would like the parent or guardian most familiar with your child to answer all questions.

Child's Name: _____

1. **Are you the child's:** Mother ☐ Father ☐ Legal guardian ☐

2. **How often do you read with your child?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

3. **How often do you talk to your child about what he/she is learning at school?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

4. **How often do you work with your child on school subjects each week?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

5. **How often do you review and discuss the completed work that your child brings home?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

6. **How often do you help your child with math?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

7. **How often do you do homework with your child?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

8. **How often do you watch television with your child?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

9. **How often do you play outside the house with your child?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

10. **How often do you play inside the house with your child?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

11. **How often do you ask your child about his/her progress in school?**

Never	Once a month	Once a week	Once a day	Always
☐	☐	☐	☐	☐

12. **How active are you in enrolling your son/daughter in sports?**

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

13. **How often do you go to your son/daughters sporting events with him/her (e.g., watch your son/daughter perform in a dance recital or at swim meets)?**

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

14. **How important is it to you to be actively involved in your son/daughter's sporting events?**

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

15. **How much do you enjoy participating in sport/physical activity?**

Very much	Quite a bit	Somewhat	A little bit	Not at all
☐	☐	☐	☐	☐

16. **How many times a week are you physically active for twenty minutes or more to the point where you are sweating and breathing hard?** ____ / week

17. **How frequently (on average) do you participate in sport/physical activity each week?**

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

18. **How often does your family use sport/physical activity as a form of family recreation (e.g., going on a bike ride together, hiking, ice skating)?**

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

19. How much do you use your own actions to encourage your son/daughter to be physically active?

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

20. How often do time pressures interfere with you being able to help your child participate in sports or active play opportunities?

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

21. How often do financial constraints prevent you from helping your child participate in sports or active play opportunities?

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

22. How often do concerns about safety interfere with you allowing your child to be involved with sport or active play opportunities near your home?

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

23. How often to you wish there were more facilities for sport or active play closer to your home?

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

24. How often do you find yourself just too tired to be involved in sports or active games with your child?

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

25. How often do any physical health problems you face make it difficult to be involved in sports or active games with your child?

Very often	Often	Sometimes	Hardly ever	Never
☐	☐	☐	☐	☐

26. I encourage my child to do physical activity and sports.

Never	Rarely	Occasionally	Sometimes	Often	Every day
☐	☐	☐	☐	☐	☐

27. I participate in physical activity or sports with my child.

Never	Rarely	Occasionally	Sometimes	Often	Every day
☐	☐	☐	☐	☐	☐

28. I provide transportation for my child to physical activity settings.

Never	Rarely	Occasionally	Sometimes	Often	Every day
☐	☐	☐	☐	☐	☐

29. I watch my child being physically active or playing sports.

Never	Rarely	Occasionally	Sometimes	Often	Every day
☐	☐	☐	☐	☐	☐

30. I tell my child when he/she is doing well in physical activities or sports.

Never	Rarely	Occasionally	Sometimes	Often	Every day
☐	☐	☐	☐	☐	☐

31. I really want my child to do well at physical activities or sports.

Very false	Mostly false	Somewhat false	Neutral	Somewhat true	Mostly true	Very true
☐	☐	☐	☐	☐	☐	☐

32. I think my child is really good at physical activities or sports.

Very false	Mostly false	Somewhat false	Neutral	Somewhat true	Mostly true	Very true
☐	☐	☐	☐	☐	☐	☐

33. I think my child could do better at physical activities or sports.

Very false	Mostly false	Somewhat false	Neutral	Somewhat true	Mostly true	Very true
☐	☐	☐	☐	☐	☐	☐

34. I wish my child wanted to do better at physical activities or sports.

Very false	Mostly false	Somewhat false	Neutral	Somewhat true	Mostly true	Very true
☐	☐	☐	☐	☐	☐	☐

35. In general, would you say your child's health is:

Excellent	Very Good	Good	Fair	Poor
☐	☐	☐	☐	☐

36. In your opinion, how physically active is your child compared to other children the same age and gender?

Much more	Moderately more	Equally	Moderately less	Much less
☐	☐	☐	☐	☐

How often would you say that your child:

37. Can't sit still, is restless, or hyperactive?

Never or not true	Sometimes or somewhat true	Often or very true
☐	☐	☐

38. Is distractible, has trouble sticking to any activity?

Never or not true	Sometimes or somewhat true	Often or very true
☐	☐	☐

39. Fidgets?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

40. Can't concentrate, can't pay attention for long?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

41. Is impulsive, acts without thinking?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

42. Has difficulty waiting turn in games or groups?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

43. Gives up easily?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

44. Cannot settle to anything for more than a few moments?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

45. Stares into space?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

46. Is nervous, high-strung or tense?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

47. Is inattentive?

Never or not true ☐ Sometimes or somewhat true ☐ Often or very true ☐

48. What ages are the children who live in your home? (Please list all!)

Boy _____ years **Girl** _____ years

Boy _____ years **Girl** _____ years

Boy _____ years **Girl** _____ years

Boy _____ years **Girl** _____ years

Boy _____ years **Girl** _____ years

49. What is the highest level of education that you have attained? _____ (Specify)

50. What is your age? _____ years

51. What is your weight? _____ pounds

52. What is your height? _____ feet _____ inches

53. What do you think is your child's weight? _____ pounds

54. What do you think is your child's height? _____ feet _____inches

55. Do you live in an urban or rural dwelling? Urban ☐ Rural ☐

56. Do you own or rent your home? Own ☐ Rent ☐

57. Select the type of dwelling that best describes your home.

- ☐ Single detached house
- ☐ Semi-detached
- ☐ Low-rise apartment (less than 5 stories)
- ☐ High-rise apartment (5 or more stories)
- ☐ Other: _____ (Specify)

58. What is your best estimate of your total family income before taxes and deductions from all sources during the past 12 months?

$_/ / / / / /

59. What is your marital status?

- ☐ Now married
- ☐ Common-law
- ☐ Living with a partner
- ☐ Single, never married
- ☐ Widowed
- ☐ Separated
- ☐ Divorced

60. Other than on special occasions (such as weddings, funerals or baptism), how often do you attend religious services or meetings?

Once a week	Once a month	3 or 4 times a year	Once a year	Not at all
☐	☐	☐	☐	☐

61. In what country were you born?

☐ Canada (Specify)

☐ Other _____

62. In which language(s) can you have a conversation?

☐ English (Specify)

☐ Other _____

63. What do you consider to be your main activity *during the past 12 months*? (MARK ONLY ONE)

☐ Caring for family

☐ Caring for family & working for pay or profit

☐ Recovering from illness / on disability

☐ Other _____ (Specify)

☐ Working for pay or profit

☐ Going to school

☐ Looking for work

☐ Retired

Thank you for completing the Parent's Questionnaire. Please do not forget to return your entry draw form on the cover letter so that you are eligible for the raffle draw and your child's class can earn another pizza party courteous of Brock University.

Appendix F

Multivariate Logistic Regressions of Non-significant Findings

Cumulative Odds of being obese or overweight/ obese and cumulative probabilities for free-time activity

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.05(0.23)	-
$\alpha 1$	0.69(0.21)	-
Free-time Activity:		
Low	-0.43(0.46)	0.61(0.18-2.06)
Low-Mod	0.50(0.43)	1.53(0.49-4.81)
Mod-High	-0.13(0.22)	0.80(0.50-1.36)
High	ref	
Model Fit[a]	x^2_3= 2.12(p=0.55)	
Score Test[b]	x^2_3 = 0.56 (p=0.91)	

a. Likelihood ratio test

b. For the proportional odds assumption

**p<0.05

Cumulative Odds of being obese or overweight/obese and cumulative probabilities for TV watching (frequency)

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.2(10.1)	-
$\alpha 1$	-0.73(0.06)	-
T.V Watching:		
Every day	0.16(0.08)	1.20(0.87-1.68)
Almost Ever day	-0.14(0.08)	0.90(0.65-1.24)
Hardly ever/Never	ref	
Model Fit[a]	x^2_2= 5.24(p=0.07)	
Score Test[b]	x^2_2 = 1.14 (p=0.57)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Cumulative Odds of being obese or overweight/obese and cumulative probabilities for TV watching (hrs.)

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	2.10(0.11)	-
$\alpha 1$	-0.61(0.087)	-
T.V Watching (hrs):		
>4	0.16(0.16)	1.46(0.92-2.32)
2-4	-0.06(0.11)	1.32(1.02-1.1.70)
0-2	ref	
Model Fit[a]	x^2_2=5.87(p=0.05)	
Score Test[b]	x^2_2 = 0.0087 (p=0.99)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Cumulative Odds of being obese or overweight/obese and cumulative probabilities for reading books (frequency)

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.2(0.10)	-
$\alpha 1$	-0.73(0.07)	-
Reading Books:		
Every day	0.04(0.12)	1.02(0.66-1.58)
Almost Ever day	-0.14(0.10)	0.85(0.58-1.25)
Hardly Ever	0.09(0.09)	1.01(0.74-1.57)
Never	ref	
Model Fit[a]	x^2_3= 2.99(p=0.39)	
Score Test[b]	x^2_3= 0.55(p=0.91)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Cumulative Odds of being obese or overweight/obese and cumulative probabilities for reading books (hrs.)

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.04(0.17)	-
$\alpha 1$	-0.56(0.16)	-
Reading Books (hrs):		
>4	-2.04(0.17)	1.70(0.74-3.93)
2-4	-0.56(0.16)	1.01(0.67-1.52)
0-2	ref	
Model Fit[a]	x^2_2=1.4(p=0.49)	
Score Test[b]	x^2_2 = 3.85(p=0.15)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Cumulative Odds of being obese or overweight/obese and cumulative probabilities for number of non-school based activities

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.31(0.31)	-
$\alpha 1$	-0.90(0.27)	-
Non-School based	-0.03(0.05)	0.97(0.89-1.07)
Model Fit[a]	x^2_1= 0.34(p=0.56)	
Score Test[b]	x^2_1= 3.35(p=0.07)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Cumulative Odds of being obese or overweight/obese and cumulative probabilities for the Godin-Shephard

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.12(0.12)	-
$\alpha 1$	-0.64(0.10)	-
Godin-Shephard (METS)	-0.001(0.001)	1.0(1.0-1.001)
Model Fit[a]	x^2_1= 1.26(p=0.26)	
Score Test[b]	x^2_1= 2.08(p=0.15)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Cumulative Odds of being obese or overweight/obese and cumulative probabilities for inactivity score

Variable	b (se(b))	OR (95% CI)
$\alpha 2$	-2.22(0.27)	-
$\alpha 1$	-0.87(0.25)	-
Inactivity	0.01(0.03)	1.01(0.96-1.07)
Model Fit[a]	x^2_1= 0.13(p=0.71)	
Score Test[b]	x^2_1= 0.85(p=0.36)	

a. Likelihood ratio test.

b. For the proportional odds assumption

**p<0.05

Inactivity: Difference between highest possible free-time activity score and actual score.